WSL MAGAZINE

DIAGONAL

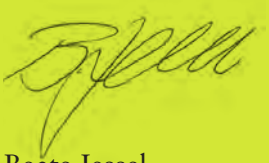
FOCUS

Expeditions: from Serengeti to Siberia

No. 2
21

Swiss Federal Institute for Forest, Snow and Landscape Research WSL

Dear Reader
An expedition is always a departure into the unknown and a venture into new territory. It requires not only meticulous preparation, but also courage, curiosity and the willingness to engage with new things – all of which are, of course, qualities that also distinguish scientists. I am convinced that the knowledge gained on such expeditions is tremendous and will ultimately help in developing solutions to urgent problems such as the climate and biodiversity crises. Without having an in-depth understanding of the interrelationships involved and without having the courage to once break new ground in science, it will not be possible to develop innovative solutions. Conversely, even the most thorough understanding of such interrelationships will be of no use if it is not processed appropriately for politics and the public to build on. That›s why I think it's so important to exchange ideas with you, our readers. What are your expectations and needs? What questions are on your mind? Please get in touch with us, for example at conferences and other events!
For me personally, taking over as director of WSL has also been like going on a kind of expedition. In addition to much that is known and familiar, I am currently discovering – with great curiosity – a lot of 'new territory'. I hope this issue of Diagonal also raises you curiosity!



Beate Jessel
Director WSL

FOCUS

Expeditions

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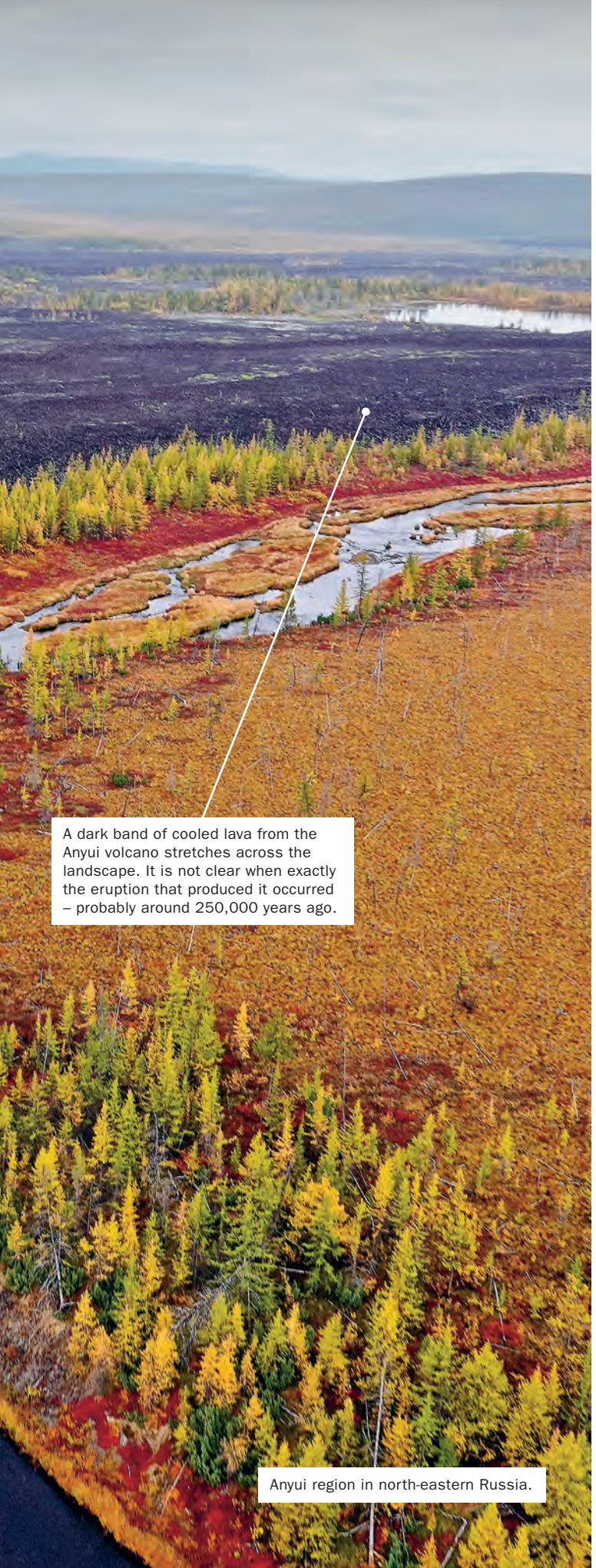
RESEARCH UP CLOSE

Cold, bears and solitude: the WSL researcher Andreas Rigling explains what he was looking for on a trip to the extreme tip of Russia and what insights the expedition promises to yield.

Journey through time in the wilderness

Some of the larches growing here fall, when they are dead, onto the lava rock. There their wood remains preserved for a long time. WSL researchers are using this wood to reconstruct the past climate and to try to determine the time of the volcanic eruption more precisely.



A dark band of cooled lava from the Anyui volcano stretches across the landscape. It is not clear when exactly the eruption that produced it occurred – probably around 250,000 years ago.

Anyui region in north-eastern Russia.

Photo: Andreas Rigling, WSL

Standing on a patch of ground where probably no human has ever walked before is a very special feeling. I was able to experience this first hand in autumn 2019 on an expedition to the Anyui volcano region in the north-easternmost corner of Russia. Here, for hundreds of kilometres, there are no signs of civilization – no houses, no roads, no people. But this is where the largest brown bears in the world live – even bigger than the grizzlies in North America. It is also where many really old trees – the reason for our expedition – can be found.

The conditions there were shaped by an eruption of the Anyui volcano many thousands of years ago, when a 56-kilometre-long band of lava, which has long since cooled, burned its way through the tundra. Growing along the edge of this gigantic lava flow are many big old larches. What's special about them is that, at the end of their lifespans, when they die and eventually fall onto the volcanic rock, their wood is preserved. Decomposition processes on the volcanic rock take place extremely slowly in comparison with on the moist soil of the tundra. Another factor that helps to preserve the wood is the cold – the trees get quasi freeze-dried. The annual rings of the preserved stems can thus be used to reconstruct long-past fluctuations in temperature.

Over the 'Road of Bones'

On our way to this unique climate and environmental archive, we flew first to Moscow and then further East to the city of Magadan. There, almost 6000 kilometres from Moscow as the crow flies, we met our colleagues from Cambridge, Krasnoyarsk and Yakutsk. There were nine of us: three researchers from WSL and the Uni-

Temperatures dropped to below zero: Andreas Rigling warming his feet besides the wood-burning stove in the tent.

versity of Cambridge, three Russian researchers and three Swiss hunters, who had rifles with them to provide protection against the bears. Magadan was once a centre for the infamous Soviet Gulag system. It was built in the 1930s by convicts, as was the only road in the region leading to Yakutsk, 2,000 kilometres to the West. The working conditions were terrible and inhumane. Even today it is still known as the 'Road of Bones' because so many people died constructing it or in the nearby penal camps.

We continued our journey in a Russian propeller plane, an Antonov, to the mining settlement of Bilibino. As the region has many mineral resources and a nuclear power plant, it is normally closed to foreigners. The local police

Photo: Cyrill Haupt, Bern

take their jobs seriously and were extremely thorough. It took them almost a week to check our permits! This meant staying stuck in Bilibino in a tiny little flat. If it hadn't been for our Russian colleagues, the whole expedition could have ended there.

In the kingdom of the bears

In the end we only had one week to explore the wilderness of the Anyui area. A transport helicopter took us to find a suitable site with lots of trees and deadwood to drop us off. We set up our tents, started the generator and spent the first night feeling frightened. The numerous 'heaps' we saw indicated that there really were quite a few bears roaming around. So during the night we took it in turns to stand guard. The next day we strung bells around the camp and left a strong halogen lamp burning each night. Despite these precautions, I never slept very well.

During the day the bears were less of a problem because we could make noises every now and then to scare them off. In the end, with these safety measures we did not, thank goodness, actually see any bears. And we still managed to take many samples, including cross-sections and cores from both living trees and deadwood. From the width of the trees' annual rings we can now reconstruct the summer temperatures of the corresponding years. In warmer summers, the trees grow faster and the annual rings are wider, whereas in colder periods the annual rings are thinner.

For further information on research in Anyui, see: *www.wsl.ch/anyui*

Hundreds of years in a tree stem

Our oldest tree sample is from a larch that lived to be around 600 years old – and then lay on the lava rock for around a further 400 years before we found it. By including data from trees that are still alive, we can now look back over a thousand years. We are still in the process of analysing the tree-ring data, but we believe that it will help to put the temperature rise of the last few decades into the context of the whole past millennium, thereby highlighting the extent of human-driven climate change.

We plan to travel to the Anyui area again and stay longer next time to collect additional tree samples from more locations. I am looking forward to going because I was so fascinated by the beauty and wildness of the landscape there. Switzerland's natural landscapes are also beautiful, but you can see signs of humans almost everywhere. In contrast, the solitude in the Anyui region is absolute and the natural environment there really unspoiled. I felt this somehow very intensely, directly and powerfully. For me it has a strong appeal. Even now, sitting here in my office, I can feel it calling me back. *(sru)*

GLACIER RESEARCH **Shrinking ice giants.** The huge glaciers in the high mountains of Asia supply millions of people with water. The WSL researcher Francesca Pellicciotti is investigating what impact their melting is having.

At the Lirung Glacier in the Langtang region of Nepal. Here Francesca Pellicciotti is unpacking the research equipment – including measuring rods and hard disks for data transmission from the weather stations

Countless glaciers stretch extensively across the Himalayas and neighbouring high mountains. They contain the third-largest ice mass on earth after the polar ice. The glaciers supply a huge area with water – extending from Tajikistan and Pakistan to India, Nepal, Tibet and China – and around 250 million people depend on them. But "these glaciers are rapidly losing mass as a result of climate change," says Francesca Pellicciotti, head of the research group 'High Mountain Glaciers and Hydrology'. She has studied several glaciers on site in High Asia with her team. They have measured, among other things, the spread and thickness of the ice with measuring rods and taken photos with drones. With the resulting data the researchers have created computer models to forecast future developments. According to their models, by 2090 the glaciers of High Asia will have shrunk to such an extent that they will supply only half the amount of water they do today. "This will be particularly drastic because in many areas there are already water shortages, and these fuel conflicts among the population," says Francesca.

It is still unclear what exactly is influencing the speed of this glacier retreat and what mechanisms are involved. Findings from the well-studied Alps cannot be transferred to the glaciers of High Asia because they are at higher altitudes than those in the Alps and have a rougher topography with prominent peaks, cliffs and gorges. In addition, many of them are covered with de-

Photo: Edoardo Soteras

bris that accumulates from the surrounding ridges. “This debris layer should really protect the ice and slow down the glacier melt,” says Francesca. But measurements have shown that the debris-covered glaciers are shrinking just as fast as all the others.

Francesca has now found an at least partial explanation for this apparent contradiction: the steep cliffs of the glaciers are not covered with debris. According to Francesca’s measurements, they form veritable melting pots, lead-

Testing an automatic weather station on the Kyzylsu glacier in Tajikistan. The glacier’s ice is hidden under a fifteen-centimetre-thick layer of debris.

For further information on Asian glaciers, see: *www.wsl.ch/glaciershrinking*

ing to the disappearance of the surrounding ice. One example is a glacier in Nepal, where such structural features are responsible for a third of the glacier’s total ice melt.

Protective vegetation

In 2017 Francesca received one of the coveted European ERC grants, which has enabled her to continue her research. She intends to use it to, among other things, get to the bottom of the mystery of the glaciers in the Karakorum Mountains in Tajikistan: they are the only glaciers in the world that are not currently shrinking. “We don’t know why,” she says, but her guess is that the ice masses could be fed by water that evaporates from the bushes and trees near the glaciers and subsequently falls as snow on the glaciers. To test her hypothesis, the researcher now wants to measure and model the water balance of the vegetation. Francesca believes that vegetation quite possibly plays an important role in the water cycle of glaciers. *(sru)*

Photo: Marin Kneib

INTERVIEW **Polar expeditions are a strain on the climate, but necessary to protect it.** The MOSAiC expedition, launched in September 2019, was the most resource-consuming and expensive of all the polar expeditions. What is the point of such projects in the first place? Are their financial and ecological costs justified? The SLF snow researcher Michael Lehning addresses such questions.

Michael Lehning, you and your research group were involved in the MOSAiC expedition. More than four hundred researchers in total travelled to the Arctic, and the whole thing cost 140 million euros. Was an expedition of this magnitude really necessary?

ML: That is a legitimate question, which we also had to think about. We weighed up the pros and cons of participating critically. Our primary concerns were not the costs, but more the energy consumption and CO_2 emissions. It was already clear during the run-up to the project that the quantities involved would be enormous. The research vessel 'Polarstern' alone would burn over seven thousand tonnes of diesel and emit more than 22,000 tonnes of CO_2 during the year it drifted through the Arctic trapped in the ice. Someone flying from Zurich to New York would have to travel about 17,000 times to produce an equivalent quantity of CO_2. In addition, the supply icebreakers made several trips to bring new crews and food.

Michael Lehning is head of the Snow Processes group at SLF and professor at ETH Lausanne.

What made you decide to join MOSAiC nevertheless?

As the project took shape, it became clear that this was a unique opportunity. Arctic sea ice has a major impact on the global climate. That's why it's important to find out what's happening to it and what consequences this has, for example for rising sea levels. Moreover, the Arctic ice will probably not survive global warming for much longer. That's why we need to study it now, before it's too late. Up until now, we have not been able to find out much about it because you can't install fixed measuring systems in the Arctic as the sea ice is in constant flux: drifting, melting, falling apart and reassembling. Having a research vessel spend a winter in the ice was, therefore, the only way to study the ice over the entire cycle from freezing to thawing. The expedition also made it possible to carry out many different investigations at the same time. This meant the resources could be used as efficiently as possible, and huge quantities of diverse and useful data collected.

For example?

One of the research teams set up a tower with meteorological sensors on the ice. These measured, at different heights, weather conditions such as temperature, humidity, wind speed and solar radiation. Collecting such data precisely is

Photo: Gaby Pfeifle Fotografik

Even while the research ship was trapped in the ice, its engines had to be kept running constantly – for heating, light and cooking, as well as for operating the scientific measuring instruments.

very complex, but many different research groups need this kind of information. Even the teams studying the water under the ice required data about the atmosphere, and my group needed such information for our snow analyses. Being able to study snow distribution, sea-ice development and what's going on under the ice all at the same time and place is extremely valuable scientifically. It helps us to understand these interconnected processes better and to represent them in computer models.

So was the expedition worth it?

We will probably only be able to answer this question conclusively in about ten years' time when we can compare the overall MOSAiC results with other research findings. However, some initial results have already been published. My research group is also in the process of publishing some results from our MOSAiC investigations on the distribution of snow, such as where it remains on the ice or how it is dispersed by, for example, the wind. The more comprehensively processes in snow, ice, water and the atmosphere can be incorporated in climate models, the more informative forecasts of future developments will become. Whether we humans can agree on effective measures to combat global warming partly depends on such forecasts.

Who makes sure that the costs of such an expedition don't outweigh its benefits?

This is something we as a research community have to evaluate ourselves. We take the evaluation seriously, especially when large projects and institutions are involved. The public has a right to

know about the benefits and environmental impacts of such projects. But I think it's important to be aware that not getting clear results is part and parcel of research. It often takes time for a breakthrough to be made and for the resources invested to pay off. You have to allow that to happen in research, otherwise you will not make any progress.

Factsheet Sustainability MOSAiC: *www.wsl.ch/mosaic-sustainability*

How important is ecological behaviour for you personally?

Very important. I live in a plus-energy house, i.e. its energy needs are more than covered by the solar energy it produces. My car is also electric.

How does that fit in with taking part in such a large expedition?

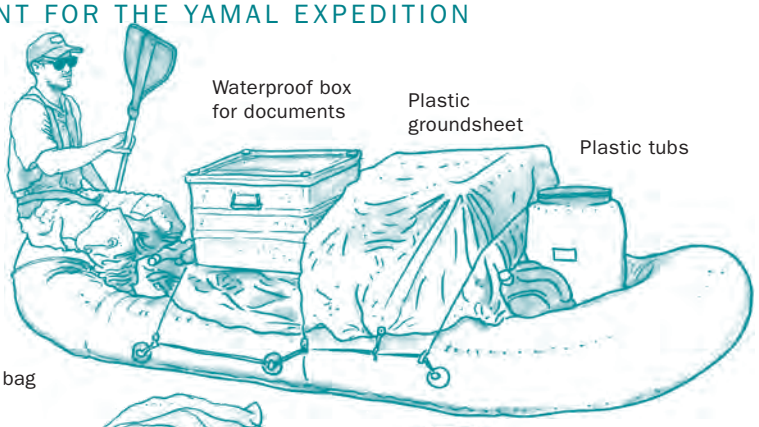
I am aware it seems contradictory to expend lots of resources and money on travelling to the poles while calling, at the same time, for the protection of the climate. That is precisely the paradox: we have to put the climate under further strain in order to understand and protect it better. That's why our group tries to keep its ecological footprint as small as possible when undertaking the small-scale expeditions we make to Antarctica. For example, we use the 'Princess Elisabeth' research station for our measurements, which is powered entirely by renewable energy sources. And we limit our equipment to the bare essentials. In addition, we use our know-how about snow and wind for research on making renewable energy in Switzerland marketable and as independent as possible of foreign countries.

In what way?

We have recently shown, for example, that the yield from photovoltaic systems in ski resorts is greater than in the lowlands. One reason is that there is no fog up there and the atmosphere is thinner and drier. Moreover, the snow reflects light, which also increases the energy yield. When planning, these factors should be taken into account more than they have been in the past. If the systems are cleverly placed, a lot of renewable energy could be produced even in winter. *(sru)*

"Arctic sea ice has a big impact on the global climate – so it's important to study what's happening to it."

EQUIPMENT FOR THE YAMAL EXPEDITION




Rain-poncho

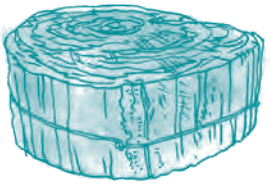

Tent


Rucksack with clothes and personal belongings


Wire


Labels


Ropes


Collection of tree discs


Pliers


Spade


Chainsaw and spare chains

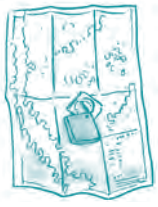

Petrol canister


First-aid kit


Measuring tape


Camping cushion


Axe


Maps


Woollen socks


Fishman's boots


Hat with mosquito net


Mosquito spray


Camera


Notebook and pen


Landing net


Crocs


Drone for aerial images


Head torch


GPS device


Satellite telephone


Espresso maker


Cooking utensils

When packing for their expedition on the Yamal Peninsula in north-west Siberia (see the world map above), the WSL dendrochronologist Patrick Fonti and his three research colleagues needed to make sure they did not forget anything important because, in the wilderness, they would be on their own. They paddled a total of 300 kilometres down the lonely Tanlavaya River. On the way, they repeatedly sawed thick discs off old tree stems preserved in the river mud to analyse later in the laboratory. They had to transport a total of 500 discs together with all their equipment in just four inflatable boats.

Illustration: Raffinerie, Zurich

The WSL researcher Anita Risch measures the activity of soil organisms under the heavily decomposed carcass of a wapiti deer. What looks like hay is actually the contents of its stomach.

Photo: Joseph Bump

Eye to eye with bison and elephants. For over twenty years, fieldwork has taken Anita Risch into the wild for several months each year. What is it like for someone to share their research sites with lions, elephants and bison?

Anita Risch's photo archive looks like the script for an adventure film: elephants and hyenas passing by less than fifty metres away in Tanzania's Serengeti National Park; a grizzly bear's paw print in the mud over fifteen centimetres wide; or an enormous bison bull standing right beside one of her research sites in the Yellowstone National Park in the USA. "When all of a sudden you hear a bison munching behind you, the best thing to do is to stay calm," says Anita. "You talk to it and wait for it to go away." For Anita, what other people would find terrifying, is what keeps her going. Coming face-to-face with a full-grown wapiti deer in rut? The 47-year-old finds it "fascinating" – even if it makes her heart beat a little faster.

Anita is head of the 'Plant-Animal Interactions' group at WSL. Over the past twenty years she has spent one to two months every year in the 'wild' in Switzerland or abroad. Through her research Anita would like to find out how large herbivorous animals, insects, plants and soil organisms influence each other in natural grasslands. Such ecosystems, which range from the hot savannahs of Africa to the cold tundra of the far north or in the mountains, cover around one third of the Earth's land surface and are home to a large diversity of species.

"It's exciting spending time in the middle of ecosystems that still function naturally. For example, the animals there can still migrate freely," she says. Savannahs and prairies are, however, often also good agricultural land. This is why the people and animals often come into conflict. Fences may cut through the migration routes of wild animals, which in turn eat the famers' crops or kill their domestic animals, and then get hunted themselves. Anita's research helps us to understand, and ultimately protect, grassland ecosystems better.

Carcasses enable new life

One of the highlights she experienced was having the opportunity to study, between 2004 and 2006, how bison and wapiti deer affect the carbon budget of grasslands in the Yellowstone National Park. In 2017, she was again in the Yellowstone National Park – this time to explore what happens to the nutrients in animals killed by wolves. For safety reasons, she and her colleague Joe Bump could only visit carcasses that were more than forty days old. If they had gone before, the risk of encountering grizzly bears would have been too great. Their research showed that special communities of microbes decompose the carcasses, thereby creating nutrient islands on which plants that are nutritious for grazing animals thrive.

If you do research in wild places, you have to be careful. In unfamiliar areas, Anita usually works closely with people who know the area very well.

A bison in Yellowstone National Park (USA). You learn to deal with such heavy visitors – it's best to leave the research site to them and wait until they go away.

There are also certain basic rules you have to follow. Do not, for example, go walking cross-country in the Serengeti – lions are hard to spot even in very short grass. This makes even going to the toilet challenging: "You choose a bush and first drive around it to make sure that no larger animals are hiding in it." Only then do you get out of the car. And if elephants get too close, everyone jumps into the car – the key is kept in the ignition and the vehicle is always parked in line with the direction of escape.

For further information on the carcasses in Yellowstone National Park, see: *www.wsl.ch/carcasses*

Nothing has ever happened to her in encounters with large animals, but it has with very small ones. An infected tsetse fly bite gave her blood poisoning. She was in Africa, far from a doctor or hospital. "It's the little things that are the most dangerous," she is convinced. Fortunately, the antibiotics she had brought with her worked and she recovered quickly.

It's not quite as dangerous as in African savannahs in the Swiss National Park, where Anita's team spends days on end climbing up and down mountain slopes. There they are exploring the interplay between animals, plants and the soil on alpine grasslands. Such work is, however, also not without its challenges: when it's wet, you can easily slip on the steep grassy slopes and fall.

Prohibited DNA samples

Obtaining permits for research and the export of biological materials often involves bureaucratic hurdles, which, in contrast with fieldwork, are more of a strain on your nerves than a threat to life. "Doing the required paperwork takes patience," says Anita. Up until now, only one project has failed: she and a Japanese colleague collected soil samples in the rainforest of Malaysia to investigate the influence of salt deficiency on soil bacteria through DNA analysis. But then Malaysia ratified the Nagoya Protocol, which regulates access to genetic resources, and applied it retroactively. It meant that working with Malaysian

Photo: : Anita Risch, WSL

Anita with the antlers of a wapiti deer that had been killed by wolves in Yellowstone National Park (USA).

DNA samples abroad was then banned, and they could not use the material they had already collected. “That was really annoying,” says Anita, and the samples are still lying unprocessed in the freezer at WSL.

Anita spent several years during her doctorate and subsequent postdoc posts alternating between the USA and Switzerland, before applying for her current WSL position in 2006. Her expeditions are the fruit of the personal contacts she has made over the years, which allow exchanges that can spark new ideas for research. “My strength is in networking with people and bringing them together across different disciplines,” she says. Her next stop – after the Corona pandemic – will be Australia, where she hopes to explore the interactions of introduced animals such as cows, sheep and rabbits, as well as plants, with native flora, fauna and soil. Anita is still not keen to leave the fieldwork only to others: “I need to be able to see and experience what I am studying myself.” *(bki)*

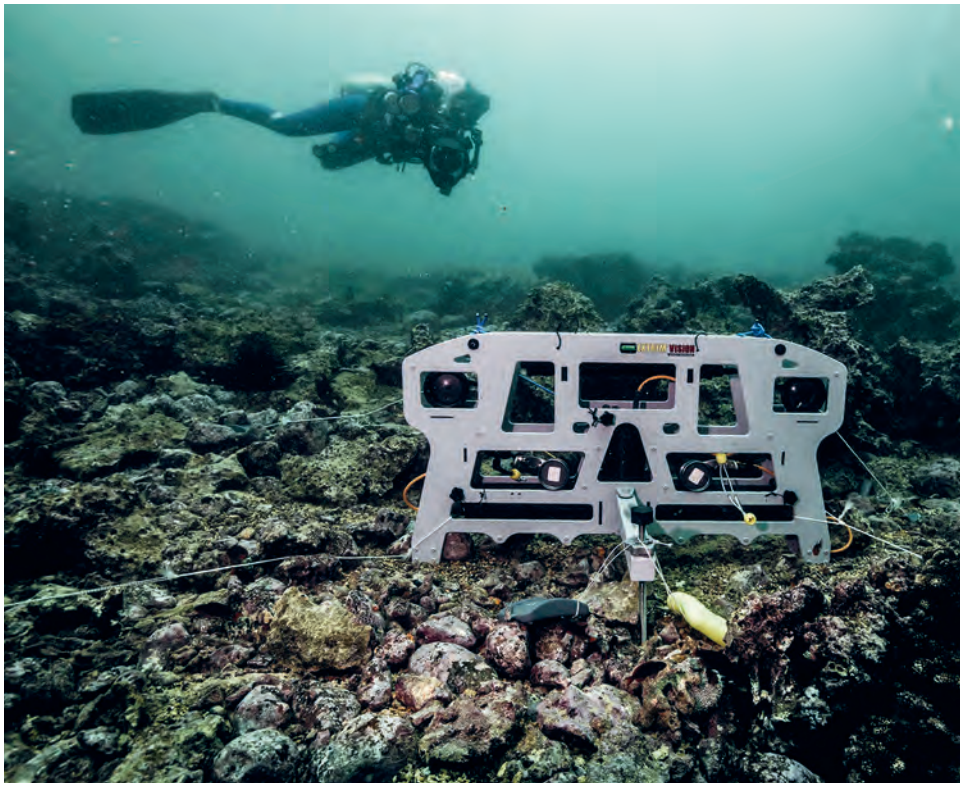
Photo: Joseph Bump

BIODIVERSITY **A vulnerable paradise.** Monitoring the state of biodiversity is time-consuming and expensive. This should soon change – thanks to so-called environmental DNA analysis. WSL researchers have tested the method in a protected area in the Pacific.

At first glance, they seem to be just a few inconspicuous rocks jutting out of the sea 500 kilometres off the coast of Colombia. But the waters around the small island of Malpelo are a natural paradise. The various ocean currents that flow together here bring in nutrients and enable life to literally explode. More than four hundred fish species cavort in shoals, some of which are huge. Among them are, in particular, many shark species such as hammerhead sharks or the endangered whale sharks.

Malpelo's exceptional biodiversity attracts not only divers but also researchers. One of them is Loïc Pellissier, an assistant professor at ETH Zurich and head of WSL's Landscape Ecology research group. He is studying how biodiversity reacts to global change. In 2018, Loïc travelled to Malpelo with an international expedition team. The goal was to test a method that should make it much easier to measure biodiversity in the future. "We can only protect biodiversity if we have information about it," says Loïc.

And biodiversity urgently needs to be protected because unique ecosystems like Malpelo are under threat worldwide. Human interventions, pollu-



This device on the seabed makes video recordings of the species swimming past – here of a diver taking part in the expedition.

Photos: Olivier Borde/Les Explorations de Monaco

An expedition member handling a seawater sample. It contains DNA from various animal species, which will later be analysed in the laboratory.

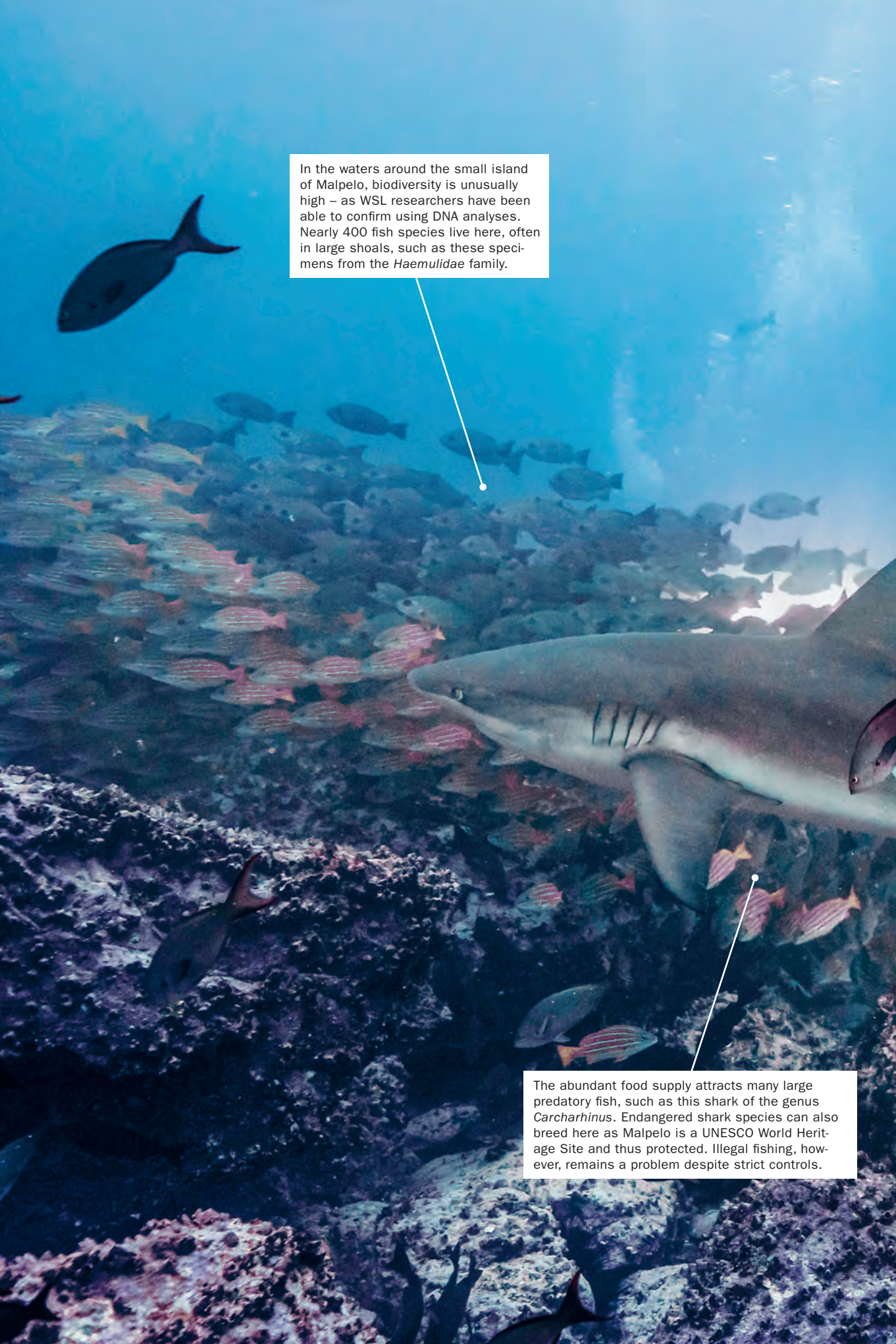
Expedition to Malpelo: *www.wsl.ch/malpelo-expedition*

tion and global warming are causing animal and plant species to die out at an unprecedented rate. "We need biodiversity. It's the basis of life," says Loïc. But for many ecosystems we don't even know what condition they are in because collecting data is time-consuming and expensive. It requires specialists who know the species. Moreover many sites are difficult to get to. As a result, surveys often take place only sporadically. They are rarely repeated and usually focus on just a few species that are easy to find.

Living organisms leave traces

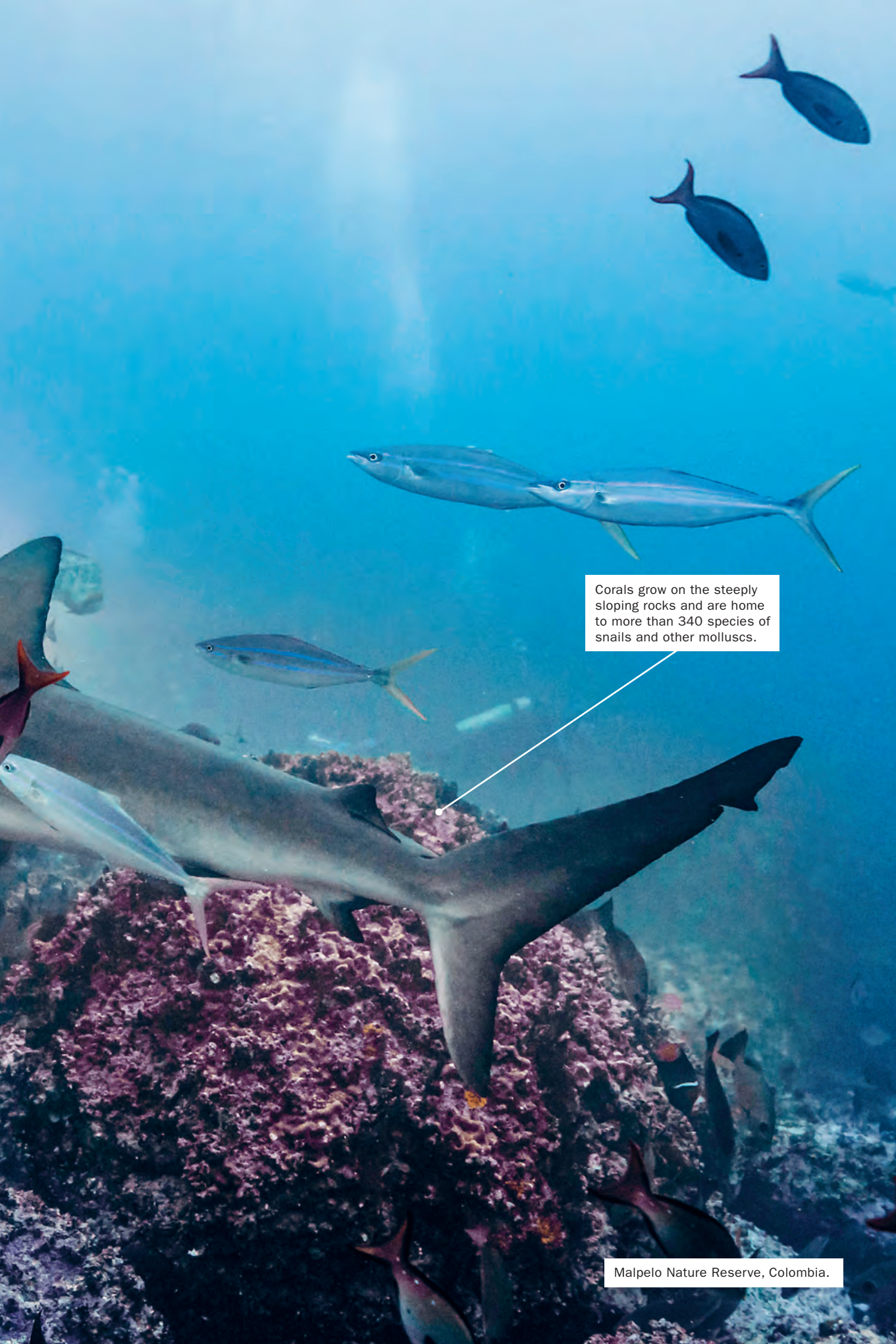
A method that Loïc and an increasing number of researchers worldwide use could help to solve these problems. It detects the presence of species indirectly, using so-called environmental DNA, or eDNA for short. For aquatic environments, all that you need is a water sample because living organisms leave genetic material in the water when they excrete or shed flakes of skin. These DNA traces are then filtered out of the water and decoded in the lab. Each species has its own characteristic DNA, which means the individual species can be identified and the species composition in the sample determined. The researchers match the DNA found with the gene sequences of many organisms already stored in databases.

The method was originally developed for bacteria, but has only recently been used for other organisms. "The question was whether it would also work with, for example, fish and whales," says Loïc. To investigate this, the team on the Malpelo expedition compared whether they could detect as many animal species with the help of eDNA as with a conventional identification method. While divers made recordings of the animal world underwater with special video cameras, the researchers collected water samples for DNA analysis.



In the waters around the small island of Malpelo, biodiversity is unusually high – as WSL researchers have been able to confirm using DNA analyses. Nearly 400 fish species live here, often in large shoals, such as these specimens from the *Haemulidae* family.

The abundant food supply attracts many large predatory fish, such as this shark of the genus *Carcharhinus*. Endangered shark species can also breed here as Malpelo is a UNESCO World Heritage Site and thus protected. Illegal fishing, however, remains a problem despite strict controls.



Malpelo Nature Reserve, Colombia.

"Our study was really successful," says Loïc. Using eDNA analysis, the researchers identified not only the species they discovered during their dives and on the video recordings, but several others as well. One finding was a very rare and shy whale species, the Dwarf sperm whale *(Kogia sima),* which no one had ever seen before off Malpelo. The researchers conducted similar experiments off the Caribbean island of Providencia and along riverbanks in the Colombian jungle, together with scientists from Colombia's Invemar Marine and Coastal Research Institute. "We were able to refine our method in the process so that it can now be used routinely."

A global network is being set up

The goal is to use eDNA analyses to establish a long-term system for monitoring biodiversity worldwide in the future. This mammoth project, in which Loïc and his group are also involved, is called 'Vigilife'. It was initiated by the French biotech company Spygen, but today around twenty research institutions and companies are also working on the project. The project aims to track changes in ecosystems by analysing water and soil samples at thousands of different locations, and to identify threats, such as the emergence of an invasive species, at an early stage. Decision-makers and planners can then use the information to decide on protective measures.

Project Vigilife:
vigilife.org/en

Loïc is currently participating in a Franco-Swiss project that is setting up a long-term monitoring system for the Rhone River. For global monitoring, however, many countries will have to contribute. Since analysing environmental DNA is relatively inexpensive, monitoring could now also become easier for poorer countries. "But local know-how is also needed," says Loïc. That is why he and other expedition members are supporting the establishment of an analysis laboratory in Colombia.

Loïc's personal history is also linked to this country. On the 2018 expedition, he met his now-wife, a Colombian researcher. Two years later, the two returned for their honeymoon to the Caribbean island of Providencia, where they had previously conducted research. But the island had just been hit by a hurricane that devastated the paradise-like place. That was an eye-opener for Loïc: "It was only then that I really realised just how vulnerable the natural world is." *(cho)*

Dominik Haas-Artho, Birmensdorf

“I like Lochergut in Zurich-Wiedikon. There are several very good Asian restaurants around here that remind me of my travels in East Asia. My favourite is ‘Miki Ramen’. Its vegetarian ramen noodle soups are really delicious.”

Photo: Bruno Augsburger, Zurich

PRESENTING ENVIRONMENTAL DATA IN AN UNDERSTANDABLE WAY

Dominik Haas-Artho is a software developer for the environmental data portal envidat.ch, which publishes data from WSL monitoring and research projects. His task is to ensure the EnviDat website is well-designed so that users can work with the environmental data as easily as possible. Here his experience as a game designer comes in handy. “I like my work because the environment and sustainability are important topics to which I can contribute at WSL”. *(bki)*

FOREST

A new tool to help forest enterprises plan forest ecosystem services for the future

Should more or less timber be used? What foresters decide today will influence which services the forest performs in future.

For centuries, foresters and forest owners have planned forest management primarily with optimal timber yields in mind. Today, forests are expected to fulfil many different services simultaneously, such as purifying water and air, providing protection against natural hazards, promoting natural diversity, absorbing carbon and serving as a place for recreation. The forest management strategy adopted affects which forest services are given priority. "This makes the planning for a forest enterprise increasingly complex and unwieldy," says Timothy Thrippleton from WSL's Sustainable Forestry group.

He and his colleagues at WSL have therefore developed a decision support tool that forest enterprises can use to simulate which services their forests will be able to provide best in the future and which less well. The tool, which is currently in its prototype stage, links a Swiss forest-growth model with forest enterprise data, as well as with criteria for how well certain forest services are performed. The tool allows users not only to vary the type of forest management, but also the future climate scenario.

The researchers used it to carry out simulations up to the year 2060 for three forest enterprises. For the two enterprises on the Central Plateau, the main objectives set were timber yield and biodiversity, as well as recreational quality, while for the enterprise in the Pre-Alps, the main focus was on the forest's protective function. It turned out that two of the enterprises had already adopted the form of management with the great-

Photo: Thomas Schöpfer

est overall benefit. "This indicates that the timber use in these enterprises is already very sustainable," Timothy says. For one enterprise, however, the targets for biodiversity and recreational benefits could be best met if timber use were reduced by 2060. The study showed that the option for all the enterprises that would have the least overall benefit would be stopping timber use completely.

"Our model can help forest enterprises base their management strategy decisions on scientific evidence," says Timothy. The tool was developed as part of the project 'SessFor' within the 'Sustainable Economy' National Research Program. A graphical user interface is currently being developed to make it easier for users to access the tool. *(bki)*

FOREST Drought stops sugar being transported to trees' roots

If no rain falls for a long time, the soil microbes in the forest go into a kind of dry sleep. Normally, these bacteria and fungi help the tree absorb trace elements and water. In return, they receive carbohydrates as food in the form of sugar. If they need less sugar, the demand decreases and the tree stops transporting sugar down from its crown.

This is one of the initial findings of a large-scale experiment in Pfynwald, a forest in Canton Valais. The WSL researchers conducting the experiment wrapped the crowns of selected hundred-year-old pines in plastic bags for a few hours and let them 'breathe in' carbon dioxide (CO_2), labelled with stable isotopes, from which the trees form sugars. The labelling enabled the researchers to track where the isotopes were transported. After only four days, some labelled sugars were already detectable in the soil, while some were still flowing even a year later out of the tree stem and needles into the soil.

The sugar transport, which stopped during drought, immediately resumed with the next rainfall and stimulated microbial activity. "The trees can then also start to form roots again and absorb nutrients," says the forest ecologist Arthur Gessler, who is head of the study. Only when it remains dry for a long time does root growth diminish and so, accordingly, does the growth of leaves and wood. As a result, the trees also store less CO_2. This means that the amount of this greenhouse gas forests store may be less than hoped in regions that are experiencing more very dry summers as a result of global warming. *(bki)*

Wrapped pines in the Pfynwald (VS), where the dry conditions have reached the limit for this tree species.

www.wsl.ch/pfynwald-en

Photo: Gottardo Pestalozzi, WSL

So that they become actively engaged as adults: let children explore the countryside!

People who spent a lot of time as children playing freely outdoors are more likely to become actively involved with the environment as adults.

The climate and biodiversity crises pose huge challenges for our society. To overcome them, everybody needs to be committed to nature conservation and environmental protection. The reality is, however, rather different as although some people are committed, many are not. The data scientist Ilka Dubernet wanted to find out why.

She assumed that spending time in natural environments during childhood shapes people's environmental commitment in adulthood. It is already known to influence to what extent a person finds nature and environmental protection important. But to move from 'considering it important' to 'becoming actively involved' requires another big step.

Ilka therefore asked nearly a thousand people how often and under what circumstances they had spent time outdoors as children. She used a questionnaire for her survey that she had developed and tested. This was easier said than done. Just take the phrase 'spending time outdoors'. Does an hour in a sandpit between blocks of flats or a game of football on the school playground count, or does it mean going into a forest, meadow or wilderness? Ilka's solution is ingenious. While an asphalted school playing ground or a street counts just as little as the way to school or to go shopping, natural environments that humans have shaped such as parks, gardens or even wasteland do count. According to her definition, "the animal and plant world, the green, the blue, the wild and the chaotic" can also be treated as natural environments. This means spending time outdoors in an urban environment may also count as exposure to nature.

Unsupervised exposure works best

The data scientist also had to find out how today's commitment to the environment could be measured, and how distortions caused by wishful thinking on the part of the survey participants could be avoided. She therefore used a so-called 'choice experiment' in which the respondents

Photo: Birgit Ottmer, WSL

were asked to decide how they would act in hypothetical situations. For example, would they prefer to share a Facebook post from a political party or actively participate in an information campaign?

The evaluation shows that spending time outdoors during childhood does indeed promote people's later commitment to the environment. What is particularly interesting is that time spent in a natural environment without being supervised or organised has the most positive influence. Ilka concludes, "So it's important not to schedule all of our children's time, but to let them do things outside on their own sometimes." Does this mean parents should send their children to the forest alone every Wednesday afternoon in the future? Ilka laughs: "Spending time outdoors encourages children to get actively involved in natural environments later on in life. It won't save the world. But at least the first steps will have been taken." *(bio)*

LANDSCAPE

The Glatt river: from backwater to urban recreation area

The Glatt flows from Lake Greifensee through Dübendorf, Wallisellen, Opfikon and Schwamendingen – a densely populated and rapidly developing area of the city of Zurich. The canton would like to upgrade the river to make it a 'green infrastructure' and thereby help to meet the increasing demand for local recreation areas. Up until now, however, there has been little research on projects that focus on recreation in urban environments, which is why Marius Fankhauser and Matthias Buchecker decided to investigate how people are using the Glatt today and how its recreational potential can be increased.

Providing places to sit encourages people to linger and enjoy the space, and enhances the quality of their recreational experience.

Popular, but too noisy

The researchers would like to find out enough about people seeking recreation and where they choose to go to be able, in future, to develop a computer model to simulate the effects of various upgrading measures on people's recreational behaviour. They therefore asked local people online not only to answer questions, but also to indicate on maps the places they found particularly attractive and those they considered disturbing, as well as the routes they preferred to take. It seems the traffic is too noisy in many areas and there are not enough places to sit around and linger. Underpasses and other dark and narrow places are considered dangerous. Nevertheless, most people said they like the Glatt. *(bio)*

Photo: Marius Fankhauser, WSL

"How attractive people find a landscape has a lot to do with how important it is for them."

Outdoor recreation and sports are more in demand than ever. This was, for instance, very apparent during the lockdown in spring 2020. Spending time in a local outdoor recreation area has a positive impact on our health. But what makes a landscape seem restful and attractive? Where do people's different interests conflict? Felix Kienast, a landscape ecologist at WSL and his colleagues will discuss these and other questions at this year's WSL conference 'Forum für Wissen' at the end of November 2021.

Felix Kienast, what makes a landscape relaxing?

Research has shown that those places that have high approval and recreational value ratings tend to be in richly textured landscapes with fine views and stretches of water. These preferences are similar around the world. Conversely, in some places, people's stress levels rise instead of falling as they do in a restful landscape. No one likes spending time in such places. People avoid, for example, urban parks at night because they are dark and confusing. And no one stays longer than necessary on busy roads because road traffic is so noisy. WSL is currently working with Empa to study places where the noise pollution is high and find out what impact this has on human health.

Do people always need water and a view to be able to relax?

Not necessarily. In addition to such generally valid preferences, personal preferences also depend on the society and individuals. They seem to be strongly influenced by how important a place is for people.

In what way?

The areas where we grew up, for example, are especially meaningful for us. We feel at home there, but outsiders might think them ugly. Social media may also play a role in influencing people's preferences, so that everyone wants to visit a particular place. An impressive recent example is the hype about the Äscher mountain restaurant in the Alpstein region. We cannot really prevent this happening, but we can at least use such cases for research. We are currently evaluating data from social media in a project with the University of Zurich to find out which landscapes are being discussed so that we can filter out landscape preferences.

But such hype about a landscape can also lead to conflicts.

Yes, indeed. Around the big cities when the weather is fine, many people concentrate at so-called 'hotspots', especially near water or in the forest. The greatest conflicts certainly arise where safety or the natural environment are affected, for example if bikers encounter hikers or where boats go too fast too close to a reed bed. But probably conflicts are also likely if people differ greatly about the significance of a landscape. Little is known about this. We would like to explore this aspect further at the conference.

Felix Kienast is Titular Professor of Landscape Ecology at ETH Zurich and a Senior Scientist at WSL.

Photo: provided

Landscapes along water are generally valued highly for recreation.

Where do we have to intervene and protect nature from humans?

There are some areas where people simply should not go, such as very sensitive biotopes like the core zones of raised bogs. In general, however, I think that stopping people visiting a landscape must be the very last resort. It is unfortunate – I believe – that such exclusion is happening increasingly often in Switzerland, even in unproblematic habitats. This undermines the Swiss tradition of allowing the public access to footpaths and trails. I am convinced that, through environmental awareness raising with, for example the help of rangers, people can be prompted to behave responsibly during recreation. With good visitor management a great deal can be achieved, as scientific evaluations at WSL of such management measures have shown.

Will the trend towards recuperating close to home continue after the pandemic?

That remains to be seen. It may even be that the backlog on long-distance travel will result in local recreational areas being relieved again. The 'Social Sciences in Landscape Research' group at WSL is currently conducting various studies on this topic, which will be presented at the 'Forum für Wissen' conference for the first time. *(lbo)*

The 'Forum für Wissen' conference on the topic 'Recreational Landscape' will take place on 30 November at WSL in Birmensdorf and online. The conference language is German. Registration is possible until mid November 2021: *www.wsl.ch/forum*

Photo: Markus Bolliger

Risk of landslides: soil wetness is a good indicator

Installing a soil wetness monitoring station near Ranflüh (Canton Bern). Here a researcher is wiring the sensors placed in the soil profile to the data logger.

Photo: Adrian Wicki, WSL

Landslides on steep slopes and embankments endanger human life and cause damage costing millions in Switzerland every year. They usually occur after heavy rainfall, as happened in summer 2021, but it is difficult to predict where and when such shallow landslides will take place.

Researchers at WSL are therefore investigating what information can be used to set up an early warning system. Previous studies have mostly focused on the amount of precipitation, but here the researchers are pursuing a new approach using measurement data on soil wetness. The data comes from 35 monitoring stations distributed across Switzerland, which continuously record moisture at depths of up to one and a half metres. The researchers compared this data with landslides from the WSL storm damage database.

The results so far are promising: "The changes in soil wetness over time seem to be very suitable for predicting the regional risk of landslides," says Adrian Wicki, a doctoral student at WSL. Predictions work well up to fifteen kilometres around the measurement site, but their accuracy decreases further away. The researchers are therefore currently exploring how computer simulations can be used to fill gaps in the measurement network.

For practical reasons, monitoring stations are usually located on flat terrain, whereas landslides occur on slopes. To find out whether measurements on flat sites are just as informative as those on steep sites, the researchers have installed various stations in the Napf area (BE) that allow direct comparisons. Preliminary evaluations indicate that the differences between the flat- and steep-slope data are only minor.

The results provide an assessment basis for a national warning system for landslides, which the Federal Office for the Environment plans to set up in the near future. *(cho)*

Matthias Gerber, Davos

“I like going running with my dog Xelie on Sunday mornings on the mountain above the lake in Davos. There are hardly any people, so you can enjoy the peace and quiet, as well as the beautiful view of the valley and the surrounding mountains. ”

Photo: Bruno Augsburger, Zürich

DEVELOPING WARNING AND INFORMATION SYSTEMS

Matthias Gerber is head of the team at SLF that develops the avalanche warning software and information systems for natural hazard managers and the public. He also spends much of his spare time around natural hazards. “I like the way my leisure activities can benefit from my work and vice versa.” In winter he trains his shepherd dog for avalanche rescue with the Swiss Alpine Club, and in summer they practice searching for buried people in rubble with REDOG. *(ro)*

Diversity is a good thing. Humans influence biodiversity – in cities too. The psychologist Nicole Bauer and biologist Marco Moretti are jointly researching how humans and 'nature' can mutually benefit each other.

Nicole Bauer is an environmental psychologist, who conducts research on the effects of the natural environment in cities on human recreation and health.

Marco Moretti is a biologist and conducts research on biodiversity and ecosystem functions, including in cities.

Biodiversity in cities is sometimes astonishingly high. Why is this?

NB: People in cities probably have a lot to do with this as biodiversity is often created incidentally. In our research in the BetterGardens project, we asked, among other things, why people choose to have a garden. The main reasons given were "recreation", followed by "meeting other people", with "food production" in third place. Promoting biodiversity was not explicitly mentioned as a motive for having a garden. However, when we asked respondents how they managed gardens, the majority were doing things to promote biodiversity. For example, they left out piles of branches for hedgehogs, applied hardly any pesticides if at all, and hung up nesting boxes for birds, as well as creating meadow areas for insects and setting up so-called 'bee hotels'.

MM: Moreover, everybody has their own style of gardening and arranging balconies, which also increases diversity. Those who don't spend much time on maintenance and leave lots of 'weeds' standing probably contribute the most to biodiversity! Having a mosaic of different habitats close to each other certainly plays a role too.

One of you is a psychologist and the other a biologist. What led you to study biodiversity in gardens together?

MM: When you study ecological systems that are dominated by humans – such as gardens – you also have to consider humans as a factor in the system. People control the occurrence and distribution of species through their behaviour and needs. As we ecologists wanted to include the human factor in our studies, we needed the help of a psychologist with the skills to interview people.

NB: At the same time, as a psychologist, I cannot find out what influence biodiversity has on human well-being, for example, without working together with biologists. Without the biological perspective, our focus is often only on the influence of structural diversity, i.e. the variety of shapes and colours, as this is easy for laypeople to notice. But there are other levels of biodiversity, such as species diversity or the diversity of interactions between different organisms. If we are interested in the impact of this kind of diversity on humans, we need the support of biologists who can measure and classify this biodiversity properly.

And what have you found out so far?

NB: In both large projects, BiodiverCity and BetterGardens, we have seen that diverse gardens and green spaces are good for people's well-being. For example, the higher

Photos: provided; Pino Covino

the number of different plant species, the more relaxed the respondents felt after spending time in their garden.

MM: One result from BiodiverCity was that, for biodiversity, it is better not to mow the lawns too often and also not all at the same time. We are really pleased to see that people have been taking this approach more and more frequently in recent years. These days you see grass left standing in many places in cities where it does not get in the way. Social science research has shown that people tend to view such grass patches positively.

So your results are already being put into practice?

NB: Yes, we were in contact with the local authorities right from the start to find out what they would like to know and where the problem areas are. This approach has the advantage that the research questions we investigate are also of interest to practitioners, who can then implement the results.

What will happen when the two projects you mentioned come to an end?

NB: The next step will be to communicate the results of the BetterGardens project to the public, i.e. to inform them about the connections between types of garden management, biodiversity and people's well-being. We also want to develop simple and effective methods to promote biodiversity in cities. This could be done with an app with concrete suggestions about how to plant and or maintain a garden in accordance with the diversity already existing in the neighbourhood.

The more diverse the plants in a garden are, the greater its recreational value.

MM: I envisage neighbourhood plans for cities that go in the direction of ecological connectivity. It would also be conceivable to have funding campaigns or compensation for private individuals who, for example, maintain and care for an old tree on their property. That would be innovative. *(lbo)*

www.bettergardens.ch/en

Image: Micha L. Rieser

Small organisms with a big impact: invasive fungi are gaining ground

They are often inconspicuous and get transported across borders with exotic plants and other goods. Such unintentionally introduced fungi are known as neomycetes. To date, about 300 neomycetes have been identified in Switzerland, and the number is increasing. A few of these fungi have spread invasively in the country and are associated with serious plant diseases, such as the false white stem canker *(Hymenoscyphus fraxineus)*, which has caused extensive ash dieback over large areas, or the chestnut blight *(Cryphonectria parasitica)*, which attacks sweet chestnut trees. Other species, such as the conspicuous octopus stinkhorn (or devil's fingers fungus), do not cause diseases, but can potentially displace native fungal species and thus disturb the natural balance in the native ecosystem.

Over the last fifty years, the number of new fungal species in Switzerland has increased exponentially, and currently two to five new species are identified each year. "The reason for this is that global trade has increased tremendously," explains Andrin Gross, a fungi researcher at WSL. He and other colleagues have compiled a fact sheet on neomycetes in Switzerland, with up-to-date information about these introduced species and how to control them. The fungi have spread rapidly in their new 'homes': "The false white stem canker has, within the past twenty years, infested ash trees all over Europe," says Andrin.

Once an invasive fungus has become established, it is difficult to get rid of it. "The most important thing is therefore prevention, as well as having appropriate guidelines for the international plant trade," says Andrin. If a new fungus is introduced, early detection is important so that infestations can be limited to a specific area and combated promptly.

The practical fact sheet on introduced fungi in Switzerland can be downloaded free of charge from WSL in German or French. *(lbo)*

The octopus stinkhorn *(Clathrus archeri)* may be displacing native species of fungi.

Photo: Markus Wilhelm

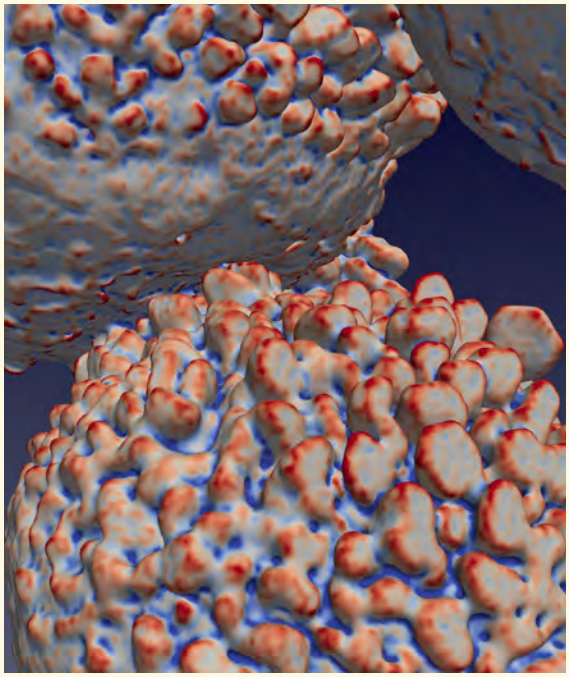
Why snow gets ‘pimples’ and how they go away

When snow falls to earth, it is at first soft and loose. But within a short space of time, the snow crystals grow together along their points of contact, i.e. they sinter. This creates compact ice bridges, and the snow layer solidifies as a result. This process can be studied in the lab with ice spheres just a few millimetres in size. Under certain conditions, these develop pimple-shaped protrusions on the surface that prevent the normal coalescence of the contact points.

Researchers at WSL and ETH Zurich have now discovered why such ‘pimples’ form. If you pour ice spheres onto a heap, they will touch each other at tiny contact points through which heat is poorly conducted. This creates a kind of build-up of heat along the contacts and leads to large temperature differences in the air between the spheres. As a result of these temperature differences, new water molecules accumulate between the spheres and pimple-like structures form. This phenomenon seems to occur only with spheres that are larger than one millimetre.

The snow pimples ‘heal’

As the pimples grow, the heat build-up at the contact points slowly dissipates, and the pimples then ‘heal’ and disappear. “This process can severely disrupt solidification through normal sintering in ice spheres,” says the snow physicist and main author of the study, Carolin Willibald. The results not only provide new insights into the sintering mechanisms, but could also have practical applications, for example when preparing ski slopes. Here, optimal sintering conditions are crucial. Preparing compact slopes with large crystals is, however, difficult in spring. The new findings help to explain why sintering is more difficult under such conditions. *(hlö, sni)*



These ice spheres are two millimetres in diameter. Pimple-like structures have formed on their surfaces, as can be seen in this computer tomography image.

Photo: Henning Löwe, SLF

Gesa von Hirschheydt, Birmensdorf

«I have an annual pass for Zurich Zoo and often walk there along the Höhenweg. I like the old oaks and beeches in the forest – even in bad weather!»

LEARNING FROM MISTAKES

Wherever people work, mistakes are made. This also happens when collecting data for the Red List of Lichens. The biologist Gesa von Hirschheydt is analysing such mistakes in her doctoral thesis at WSL. This involves calculating the probability that lichens will not be detected during the survey. In this way, she is helping to make the results of the currently ongoing revision of the Red List more accurate. “I find lichens really fascinating organisms. They constitue a group of species, we still know so little about.” *(lbo)*

Photo: Bruno Augsburger, Zurich

OUTLOOK DIAGONAL NO. 1, 2022

What is the state of our environment? What did it look like in the past? What direction will it take in the future? To answer such questions, researchers often have to do detective work. They evaluate traces in environmental archives, such as tree rings, thereby uncovering relationships invisible to the naked eye. Sometimes it also helps to look at snow from a distance, for example using drones. In the next issue of Diagonal, we will provide insights into the work of such 'environmental detectives'.

Photos: Markus Mallaun; Gottardo Pestalozzi; WSL

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For single copies, contact:
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IMPRINT

Publisher
Swiss Federal Research Institute WSL

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Translation: Silvia Dingwall, Nussbaumen

Design:
Raffinerie AG für Gestaltung, Zurich
Layout: Sandra Gurzeler, WSL

Printing: cube media AG, Zurich
Paper: 100 % recycled

Circulation and frequency of publication: 500, twice a year

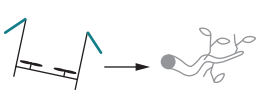
The WSL magazine Diagonal is also published in German and French.

Cite as:
Swiss Federal Research Institute WSL, 2021: WSL magazine Diagonal, 2 / 21. 36 pp., ISSN 2297-6175

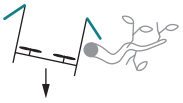
PEOPLE

The Diagonal editorial team, from left to right, top row: Sara Niedermann, Birgit Ottmer, Beate Kittl; bottom row: Claudia Hoffmann, Sandra Gurzeler, Lisa Bose

THE ‘HEDGEHOG’ DRONE

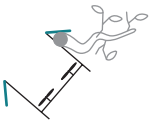


1. Drone approaches

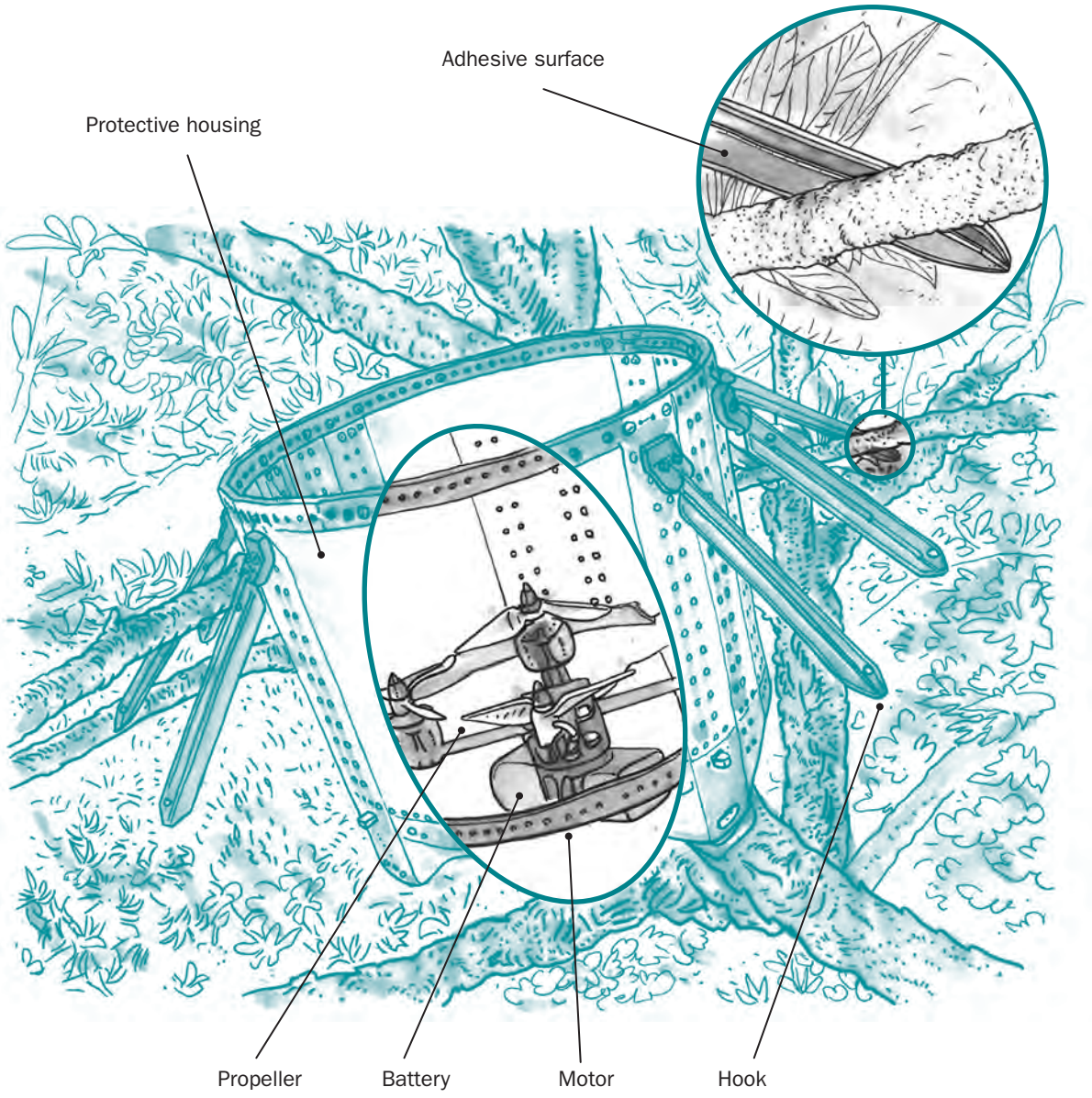


2. Drops down onto the object

3. The ‘hooks’ snap into place



4. Now settled in a stable position



Researchers at WSL have developed a small drone that can settle on tree branches. Attached to its protective housing are ‘hooks’ with undersides made of special material that adheres well to the branches. Once it reaches its destination, the propellers are turned off. This allows the drone, known as the ‘Hedgehog’, to collect data silently over a long period of time without consuming much energy. Various measuring devices can be mounted on it, for example to make acoustic recordings or to observe wildlife in the treetops with a camera. *(sni)*

Video at:
www.wsl.ch/object

Illustration: Raffinerie; Cover: Adrian Wicki, WSL

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RESEARCH FOR PEOPLE AND THE ENVIRONMENT

The Swiss Federal Institute for Forest, Snow and Landscape Research WSL conducts research into changes in the terrestrial environment, as well as into the use and protection of natural spaces and cultural landscapes. It monitors the condition and development of the forests, landscapes, biodiversity, natural hazards, and snow and ice, and develops sustainable solutions for problems that are relevant to society – together with its partners from science and society. WSL plays a leading international role in these research areas, providing the basis for sustainable environmental policy in Switzerland. WSL employs more than 500 people in Birmensdorf, Cadenazzo, Lausanne, Sion and Davos (WSL Institute for Snow and Avalanche Research SLF). It is a Swiss federal research centre and part of the ETH Domain. You can find WSL's annual report online at: www.wsl.ch/annualreport.


WSL

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