

Car ‘splatometer’ tests reveal huge decline in number of insects

Research shows abundance at sites in Europe has plunged by up to 80% in two decades

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Dead insects on a car windscreen in Wyoming, US. Photograph: Colby Lysne/Alamy

Two scientific studies of the number of insects splattered by cars have revealed a huge decline in abundance at European sites in two decades.

The research adds to growing evidence of what some scientists have called an “**insect apocalypse**”, which is threatening a collapse in the natural world that sustains humans and all life on Earth. A third study shows plummeting numbers of aquatic insects in streams.

The survey of insects hitting car windscreens in rural **Denmark** used data collected every summer from 1997 to 2017 and found an 80% decline in abundance. It also found a parallel decline in the number of swallows and martins, birds that live on insects.

The second survey, in the UK county of Kent in 2019, examined splats in a grid placed over car registration plates, known as a “splatometer”. This revealed 50%

fewer impacts than in 2004. The research included vintage cars up to 70 years old to see if their less aerodynamic shape meant they killed more bugs, but it found that modern cars actually hit slightly more insects.

“This difference we found is critically important, because it mirrors the patterns of decline which are being reported widely elsewhere, and insects are absolutely fundamental to food webs and the existence of life on Earth,” said Paul Tinsley-Marshall from **Kent Wildlife Trust**. “It’s pretty horrendous.”

“Most naturalists who are out in nature have seen this coming over a long time,” said Anders Pape Møller from the Paris-Sud University in France, who has been visiting the Danish study area for 50 years. “My colleagues remember going on summer holidays as children and their parents had to stop their car to clean the windscreen so they could continue. This is certainly not a problem any more.”

Insect population collapses have been reported in **Germany** and **Puerto Rico**, and the **first global scientific review**, published in February 2019, said widespread declines threatened to cause a “**catastrophic collapse of nature’s ecosystems**”. Insects pollinate three-quarters of crops and another recent study showed widespread **losses of such insects** across Britain.

The causes of decline are the destruction of natural habitat, pesticides and the impacts of the climate crisis. Light pollution has also been cited as a key “**bringer of insect apocalypse**”.

The **survey in Kent** analysed nearly 700 car journeys reported by volunteers from June to August 2019. The bug splats on the registration plate were counted to calculate the number of impacts per kilometre. This was 50% lower than an RSPB survey using the same methodology found in 2004.



A 'splatometer' is held over a car registration plate in Kent. Photograph: Kent Wildlife Trust

“The most surprising thing was how rarely we actually found anything on the plate at all,” said Tinsley-Marshall. This was despite the data showing that modern cars hit more bugs, perhaps because older models push a bigger layer of air – and insects – over the vehicle.

The Danish research, **published** in the journal *Ecology and Evolution*, used data from an average of 65 car journeys a year on the same stretch of road and at the same speed between 1997 and 2017. Møller took account of the time of day, temperature, wind speed and date of the journey and found an 80% decline in insect abundance over the 21-year period. Checks using insect nets and sticky traps showed the same trend.

Møller said the causes were likely to be “a bit of everything”, but noted significant changes due to global heating. “In my 50 years, the temperature in April, May and June has increased by 1.5C [2.7F] on average in my study area,” he said. “The amount of rain has increased by 50%. We are talking about dramatic differences.”

The stream research, **published** in the journal *Conservation Biology*, analysed weekly data from 1969 to 2010 on a stream in a German nature reserve, where the only major human impact is climate change.

“Overall, water temperature increased by 1.88C and discharge patterns changed significantly. These changes were accompanied by an 81.6% decline in insect abundance,” the scientists reported. “Our results indicate that climate change

has already altered [wildlife] communities severely, even in protected areas.”

Matt Shardlow, the chief executive of the charity **Buglife**, said: “These new studies reinforce our understanding of the dangerously rapid disappearance of insect life in both the air and water. It is becoming clear that the four horsemen of the insect apocalypse are climate change, habitat destruction, habitat fragmentation and pollution. It is essential we create more joined up space for insects that is safe from pesticides, climate change and other harm.”

Most scientific research to date has shown serious declines in the number of insects in the places studied. “There is no doubt about this,” said Møller. “What there is slight doubt about is the extent to which this occurs across geographical and temporal scales.”

Long-term studies are rare and mostly from **Europe** and North America, with a few ranging from Australia to China and Brazil to South Africa, but hardly any elsewhere. There has also been discussion about the best methodologies among researchers.

“But that is not the main point,” said Tinsley-Marshall. “I think it’s pretty clear that something pretty catastrophic is going on.” Kent **Wildlife** Trust is now working on a smartphone app to make it easier for volunteers to provide insect splat data.

Climate change on track to cause major insect wipeout, scientists warn

Insects are vital to ecosystems but will lose almost half their habitat under current climate projections

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The famous migration of the North American monarch butterfly is one of the most well-documented examples of an insect species affected by climate change. Photograph: Joel Sartore/NG/Getty Images

Global warming is on track to cause a major wipeout of insects, compounding already severe losses, according to a new analysis.

Insects are vital to most ecosystems and a widespread collapse would cause extremely far-reaching disruption to life on Earth, the scientists warn. Their research shows that, even with all the carbon cuts already pledged by nations so far, climate change would make almost half of insect habitat unsuitable by the end of the century, with pollinators like bees particularly affected.

However, if climate change could be limited to a temperature rise of 1.5C - the very ambitious goal included in the global Paris agreement - the losses of insects are far lower.

The new research is the most comprehensive to date, analysing the impact of different levels of climate change on the ranges of 115,000 species. It found plants are also heavily affected but that mammals and birds, which can more easily migrate as climate changes, suffered less.

“We showed insects are the most sensitive group,” said Prof Rachel Warren, at the University of East Anglia, who led the new work. “They are important because ecosystems cannot function without insects. They play an absolutely

critical role in the food chain.”

“The disruption to our ecosystems if we were to lose that high proportion of our insects would be extremely far-reaching and widespread,” she said. “People should be concerned - humans depend on ecosystems functioning.” Pollination, fertile soils, clean water and more all depend on healthy ecosystems, Warren said.

In October, **scientists warned of “ecological Armageddon”** after discovering that the number of flying insects had plunged by three-quarters in the past 25 years in Germany and very likely elsewhere.

“We know that many insects are in rapid decline due to factors such as habitat loss and intensive farming methods,” said Prof Dave Goulson, at the University of Sussex, UK, and not part of the new analysis. “This new study shows that, in the future, these declines would be hugely accelerated by the impacts of climate change, under realistic climate projections. When we add in all the other adverse factors affecting wildlife, all likely to increase as the human population grows, the future for biodiversity on planet Earth looks bleak.”



A dragonfly lands on a stalk of wheat. Many insects are in rapid decline due to factors such as habitat loss and intensive farming methods. Photograph: Todd Korol/Reuters

In the new analysis, **published in the journal Science**, the researchers gathered data on the geographic ranges and current climate conditions of 31,000 insect species, 8,000 birds, 1,700 mammals, 1,800 reptiles, 1,000 amphibians and

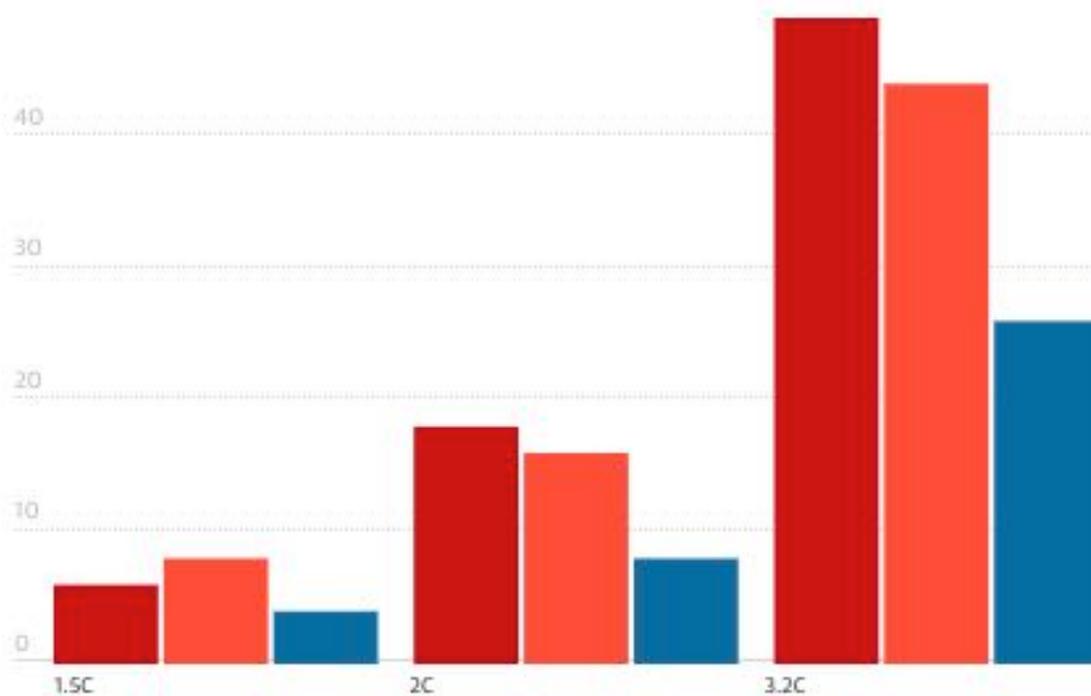
71,000 plants.

They then calculated how the ranges change when global warming means some regions can no longer support particular species. For the first time in this type of study, they included the 1.5C Paris target, as well as 2C, the longstanding international target, and 3.2C, which is the rise the world will experience by 2100 unless action is taken beyond that already pledged.

Insect ranges could be seriously cut by climate change

Percentage of species losing more than half their range by 2100

■ Insects ■ Plants ■ Vertebrates



Guardian Graphic | Source: Warren et al, Science

The researchers measured the results in two ways. First, they counted the number of species that lose more than half their range and this was 49% of insect species at 3.2C, falling to 18% at 2C and 6% at 1.5C. Second, they combined the losses for each species group into a type of average measure.

“If you are a typical insect, you would be likely to lose 43% of your range at 3.2C,” Warren said. “We also found that the three major groups of insects responsible for pollination are particularly sensitive to warming.”

Guy Midgley, at University of Stellenbosch, South Africa and not part of the research team, said the new work built on previous studies but is far more comprehensive. He said major impacts on wildlife would be expected given the

potential scale of climate change: “Global average surface temperatures in the past two million years have rarely approached the levels projected over the next few decades.”



A bee forages in a garden. The UK bee population has seen a severe decline over the past 20 years.
Photograph: Ian Jacobs/Alamy

Warren said the new work had taken account of the ability of species to migrate, but had not been able to include the impact of lost interactions between species as ranges contract, or of the impacts of more extreme weather events on wildlife. As both of those would increase the losses of range, Warren said the estimates of losses made were likely to be underestimates.

Warren said that the world’s nations were aware that more action on climate change is needed: “The question is to what extent greater reductions can be made and on what timescale. That is a decision society has to make.”

Another **study published in Science** on Thursday found that one third of the world’s protected areas, which cover 15% of all land, are now highly degraded by intense human pressure including road building, grazing, and urbanisation.

Kendall Jones, at the University of Queensland, Australia, who led the work, said: “A well-run protected area network is essential in saving species. If we allow our protected area network to be degraded there is a no doubt biodiversity

losses will be exacerbated.”

Insect declines: new alarm over mayfly is ‘tip of iceberg’, warn experts

Modest pollution in many English rivers is enough to kill 80% of eggs, increasing concerns over insects which are vital to all ecosystems

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Clouds of emerging mayflies were once a regular sight on English summer evenings but pollution has significantly affected numbers. Photograph: FLPA/REX/Shutterstock

Modest levels of pollution found in many English rivers are having a devastating impact on mayflies, new research suggests, killing about 80% of all eggs.

Clouds of emerging mayflies were once a regular sight on English summer evenings and they are a key part of the food chain that supports fish, birds and mammals. The finding that even pollution well below guidelines can cause

serious harm adds to concerns about plummeting insect numbers.

In October, a study found that the abundance of **flying insects has plunged by 75%** in 25 years, prompting warnings that the world is “on course for ecological Armageddon”, with profound impacts on human society.

Paul Knight, chief executive of Salmon and Trout Conservation (STC), which is conducting an **in-depth three-year survey of rivers**, said: “The results of this groundbreaking new study are irrefutable. We believe this is just the tip of the iceberg. Lose your invertebrates and other species will follow.”

The new research looked at the blue-winged olive, a common mayfly present across the British Isles and most of continental Europe. Its numbers have fallen significantly in recent decades and it has almost vanished from some English rivers.

The prime suspects for this decline are fine sediment and phosphate pollution in rivers, which are washed off farmed fields and also result from untreated sewage. Some research has been done on how the larval and adult stages of mayflies are affected by pollution, but not on their eggs.

“The young life stages are the most vulnerable, just as with human babies,” said Nick Everall, at the Aquascience Consultancy and who led the research **published in the journal Environmental Pollution**. Blue-winged olive eggs are laid on river beds and then have to survive for up to eight months over winter before hatching into nymphs.

However, experiments in the laboratory found that the fine sediment settles on the eggs and suffocates them, by preventing oxygen transferring into the egg. The sediment can also allow fungus to grow and kill the eggs, while phosphate is known to affect the development of eggs.

At levels very close to existing guideline limits - 25mg per litre of fine sediment and 0.07 mg/l of phosphate - the researchers found 80% of the eggs died. Most English rivers contain more phosphate than this – **only 17% have “good ecological status”** under EU rules. High sediment levels are also frequently found, with 40% of rivers having more than 10mg/l – a level the new work shows is harmful to the mayfly eggs – and 10% more than 25mg/l.

“Mayflies such as the blue-winged olive are a crucial component in the aquatic food chain but numbers have declined substantially in many UK rivers over the past 30 years, particularly in chalk streams,” said Everall, whose study was

supported by STC.

“Their continuing loss can affect the survival of other important species such as wild fish, bird life and mammals,” he said. “This research shows even modest levels of sediment and phosphate, below current national thresholds, have a significant impact on egg survival.”

Knight said: “Current regulations are simply not rigorous enough to detect the extent of the problem. This latest study supports growing concern about current guidelines.” He said STC was working with local Environment Agency teams to develop more appropriate targets, but that these need to be implemented nationally.

Everall said climate change was unlikely to be a factor in the mayfly declines, as the rise in water temperatures have not been sufficient to date, but he said pesticides could be playing a role. In December, “alarming” test results showed most **British rivers are polluted by powerful insecticides** called neonicotinoids and in 2013 research in the Netherlands revealed neonicotinoid pollution in water led to **sharp drops in insect numbers**.

Warning of 'ecological Armageddon' after dramatic plunge in insect numbers

Three-quarters of flying insects in nature reserves across Germany have vanished in 25 years, with serious implications for all life on Earth, scientists say

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Flying insects caught in a malaise trap, used by entomologists to collect samples. Photograph: Courtesy of Entomologischer Verein Krefeld

The abundance of flying insects has plunged by three-quarters over the past 25 years, according to a new study that has shocked scientists.

Insects are an integral part of life on Earth as both pollinators and prey for other wildlife and it was known that some species **such as butterflies** were declining. But the newly revealed scale of the losses to all insects has prompted warnings that the world is “on course for ecological Armageddon”, with profound impacts on human society.

The new data was gathered in nature reserves across Germany but has implications for all landscapes dominated by agriculture, the researchers said.

The cause of the huge decline is as yet unclear, although the destruction of wild areas and widespread use of pesticides are the most likely factors and climate change may play a role. The scientists were able to rule out weather and changes to landscape in the reserves as causes, but data on pesticide levels has not been collected.

“The fact that the number of flying insects is decreasing at such a high rate in such a large area is an alarming discovery,” said Hans de Kroon, at Radboud University in the Netherlands and who led the new research.

“Insects make up about two-thirds of all life on Earth [but] there has been some kind of horrific decline,” said Prof Dave Goulson of Sussex University, UK, and

part of the team behind the new study. “We appear to be making vast tracts of land inhospitable to most forms of life, and are currently on course for ecological Armageddon. If we lose the insects then everything is going to collapse.”

The research, [published in the journal Plos One](#), is based on the work of dozens of amateur entomologists across Germany who began using strictly standardised ways of collecting insects in 1989. Special tents called malaise traps were used to capture more than 1,500 samples of all flying insects at 63 different nature reserves.



The malaise traps set in protected areas and reserves, which scientists say makes the declines even more worrying. Photograph: Courtesy of Entomologischer Verein Krefeld

When the total weight of the insects in each sample was measured a startling decline was revealed. The annual average fell by 76% over the 27 year period, but the fall was even higher – 82% – in summer, when insect numbers reach their peak.

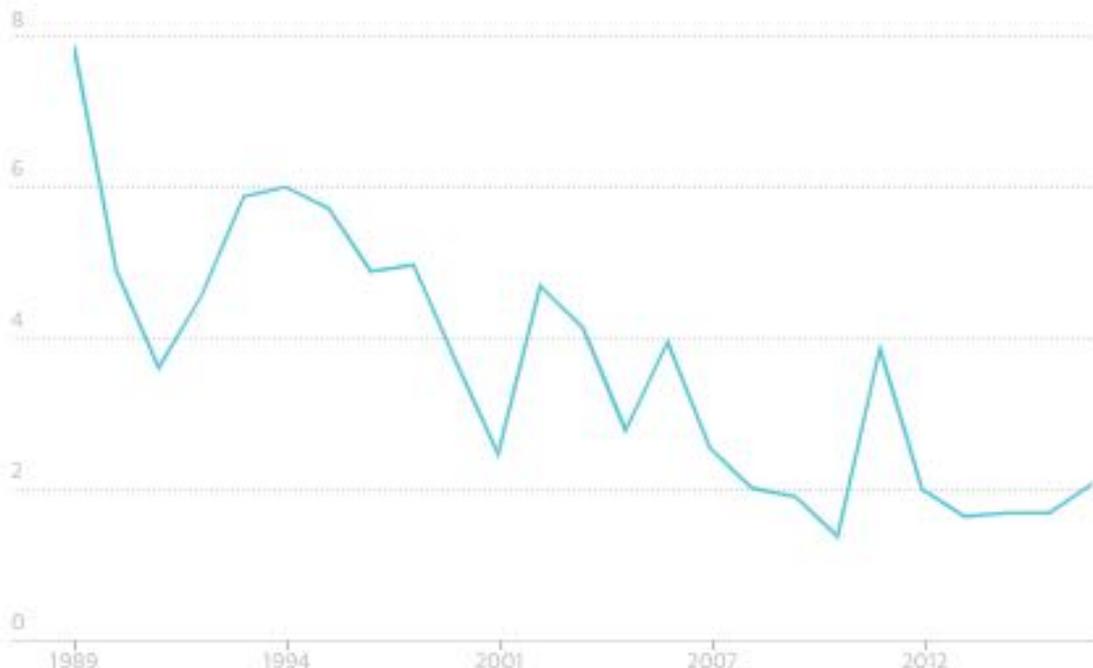
Previous reports of insect declines have been limited to particular insects, such as [European grassland butterflies](#), which have fallen by 50% in recent decades. But the new research captured all flying insects, including wasps and flies which are rarely studied, making it a much stronger indicator of decline.

The fact that the samples were taken in protected areas makes the findings even

more worrying, said Caspar Hallmann at Radboud University, also part of the research team: “All these areas are protected and most of them are well-managed nature reserves. Yet, this dramatic decline has occurred.”

Insect abundance has fallen by 75% over the last 27 years

Average grams per day



Guardian graphic | Source: Hallmann et al, PLOS ONE

The amateur entomologists also collected detailed weather measurements and recorded changes to the landscape or plant species in the reserves, but this could not explain the loss of the insects. “The weather might explain many of the fluctuations within the season and between the years, but it doesn’t explain the rapid downward trend,” said Martin Sorg from the Krefeld Entomological Society in Germany, who led the amateur entomologists.

Goulson said a likely explanation could be that the flying insects perish when they leave the nature reserves. “Farmland has very little to offer for any wild creature,” he said. “But exactly what is causing their death is open to debate. It could be simply that there is no food for them or it could be, more specifically, exposure to chemical pesticides, or a combination of the two.”

In September, a chief scientific adviser to the UK government warned that regulators around the world have **falsely assumed that it is safe to use pesticides at industrial scales** across landscapes and that the “effects of dosing whole

landscapes with chemicals have been largely ignored”.

The scientists said further work is urgently needed to corroborate the new findings in other regions and to explore the issue in more detail. While most insects do fly, it may be that those that don't, leave nature reserves less often and are faring better. It is also possible that smaller and larger insects are affected differently, and the German samples have all been preserved and will be further analysed.

In the meantime, said De Kroon: “We need to do less of the things that we know have a negative impact, such as the use of pesticides and the disappearance of farmland borders full of flowers.”



As well as being pollinators insects provide food for birds and other animals and help control pests.
Photograph: Kevin Elsby/Alamy

Lynn Dicks at the University of East Anglia, UK, and not involved in the new research said the work was convincing. “It provides important new evidence for an alarming decline that many entomologists have suspected is occurring for some time.”

“If total flying insect biomass is genuinely declining at this rate – about 6% per year – it is extremely concerning,” she said. “Flying insects have really important ecological functions, for which their numbers matter a lot. They pollinate flowers: flies, moths and butterflies are as important as bees for many flowering plants, including some crops. They provide food for many animals –

birds, bats, some mammals, fish, reptiles and amphibians. Flies, beetles and wasps are also predators and decomposers, controlling pests and cleaning up the place generally.”

Another way of sampling insects – car windscreens – has often been anecdotally used to suggest a major decline, with people remembering many more bugs squashed on their windscreens in the past.

“I think that is real,” said Goulson. “I drove right across France and back this summer – just when you’d expect your windscreen to be splattered all over – and I literally never had to stop to clean the windscreen.”