Chemical Pollution

The Silent Killer of UK Rivers

August 2022

A report by

THE PESTICIDE COLLABORATION

buglife

RSPB

WildFish.

Contents

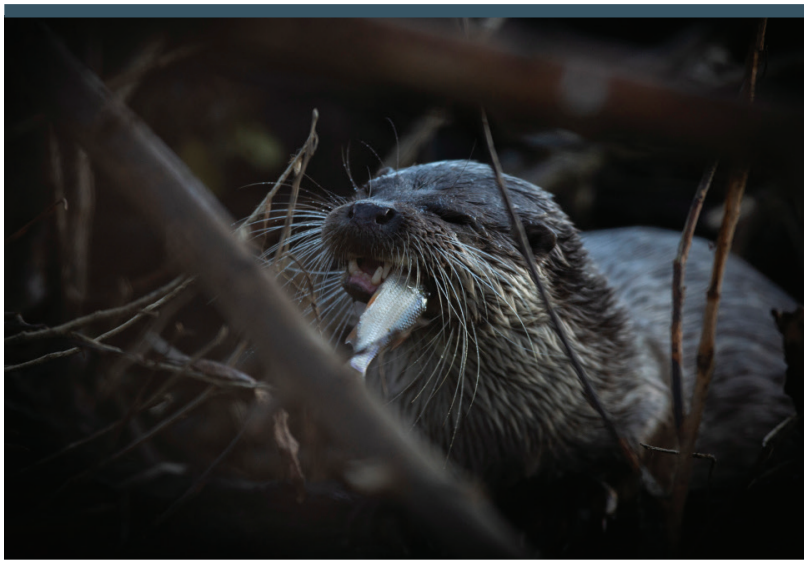
The problem

> “The most alarming of all man’s assaults on the environment is the contamination of air, earth, rivers and sea with dangerous and even lethal materials”
>
> – Rachel Carson, Silent Spring, 1962

It’s a fact that our everyday lives are filled with chemicals. From the cleaning products we use, to the medicines we take and the food we eat - chemicals really are everywhere.

Chemical use provides many benefits. However, when we’re finished with chemicals, they don’t just disappear. Pesticides, pharmaceuticals and plasticisers (chemicals used to soften plastic) leak into the environment, entering our air, soil and water, causing unwanted effects.

The sheer number of different chemicals, and the complicated way they interact with each other, means we cannot possibly understand the real-world impacts. But we do know that chemicals persist in the environment for months or even years. On top of that, the products that are released when they break down can also be harmful, sometimes more than the original chemical!



Chemicals are rarely contained in the area they are applied or originate from, so contaminate nearby habitats.[1,2] We know that chemicals in the environment cause significant harm to wildlife – on land (such as the impact of neonicotinoid insecticides on bee populations[3]), in the sea (such as perfluoroalkyl substances (PFAS) on killer whales[4]) and on plants and animals in freshwater[5].

We also know that many terrestrial and freshwater species are in decline and at risk of extinction[6]. In 2021, scientists concluded that we had crossed the planetary boundary for chemical pollution, meaning that levels of chemicals in the environment are no longer safe for humanity[7]. What we know, shows we should be very concerned.

Chemicals are just one of a number of pollutants threatening our freshwater ecosystems. Sewage, plastic, excess nutrients and waste from farmland all contribute to the dire state of our rivers. Environment Agency data from 2020 showed that all English rivers failed to meet overall quality tests for pollution. Not a single river achieved good chemical status, and only 14% of rivers in England achieved good ecological status[8]. Although sewage discharge in rivers has rightly had the spotlight shone on it in recent years[9], 40% of river pollution is from agriculture[10] and the impact of this on freshwater ecosystems cannot be ignored.

What can aquatic invertebrates tell us about river health?

Aquatic invertebrates, which can sometimes live for years, spend most, if not all, of their lives in rivers. Over this time they are directly exposed to the conditions of the water, and often need good water quality to reach maturity.

Chemical impacts on invertebrates can be direct, causing death, or indirect, where physiological and behavioural processes are disturbed.

An example of an indirect effect is reduced emergence. Reductions of up to 39%-65% in damselfly (***Ischnura elegans***) nymphs exposed to (0.1 µg/l - 10 µg/l) of the neonicotinoid thiacloprid have been recorded[11]. Another example is alterations to body size. Reductions in head length in ***Baetis*** species and thorax length in ***Epeorus*** species have been observed following 12 hour pulses of the neonicotinoid imidacloprid as low as 0.1 µg/l[12]. Size changes have negative implications for reproductive success. Such modifications can be significantly problematic for the food web and ecosystem functioning overall.

Some invertebrate species are more tolerant to chemical exposure than others. Organisms that are slower to develop, like mayfly species, are at higher risk than more rapidly developing groups due to chemical exposure from multiple pulses over the course of their development[12]. So, when sensitive species are missing and tolerant types remain, chemical pressure is indicated.

Scientists have taken this one step further and assigned tolerance values to different aquatic invertebrates. Calculations can be done using these values, allowing the scale of chemical impact at a particular site to be determined.

Using this method also provides insight into river health over a much broader period of time than that of a ‘single spot’ water sample which is more of a snapshot in time.

WildFish have recently published their latest **Riverfly Census** results. This is a national survey covering 12 English rivers. On each river, various samples were collected and analysed to look at invertebrate biodiversity and the pressures impacting freshwater habitats. Initially completed in 2015, 2016 and 2017, the surveys were repeated in 2021 to see if anything had changed.

As previously mentioned, exposure to chemicals alters invertebrate community composition. WildFish used the calculation known as SPEAR (the **Spe**cies **a**t **R**isk metric) to work out the scale of chemical impact being indicated at their sites based on the invertebrate communities present.

Looking at this data has allowed us to determine if, and how, chemicals are impacting aquatic wildlife, and whether the problem is getting better or worse.

Our findings

Chemical pressure

We looked at the 2021 SPEAR scores and compared them to results from previous years. The data showed that there was not much difference in spring between the different years, but the autumn results told a different story. The proportion of sites where the invertebrate community indicated Poor or Bad on the chemical stress scale was considerably greater in autumn 2021, compared to autumn results from 2015, 2016 and 2017*.

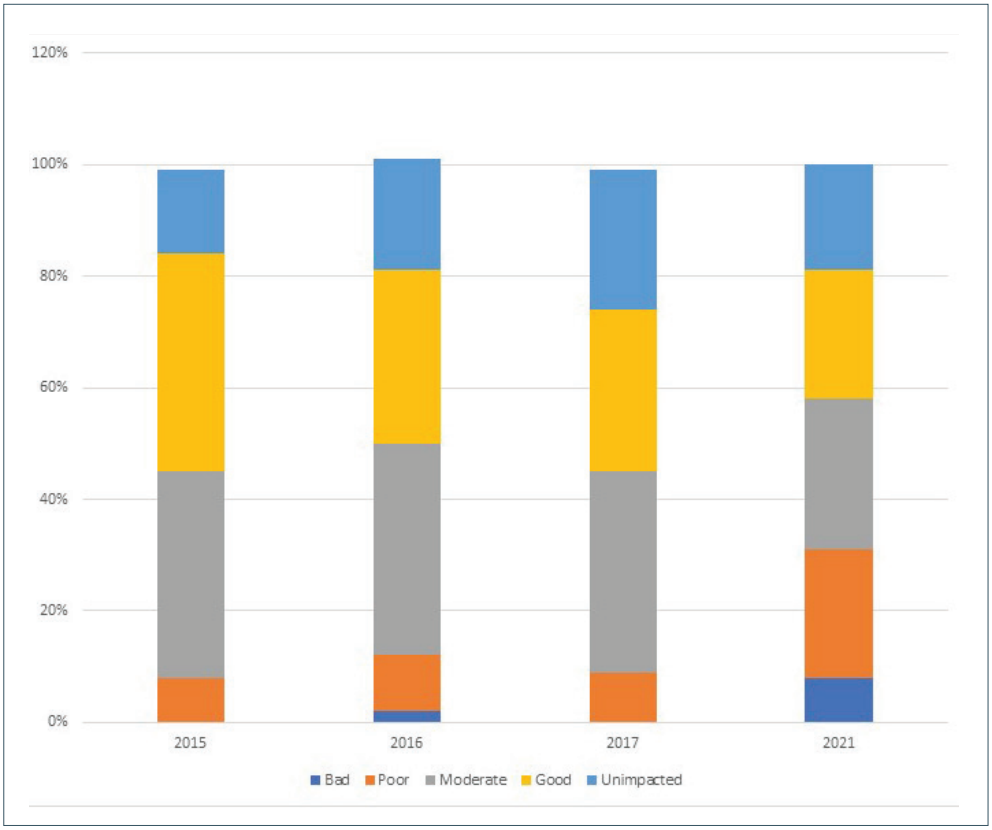


Figure 1: The percentage of rivers for each chemical stress score in autumn in 2015, 2016, 2017 and 2021. The blocks representing bad and poor are much larger in 2021 than they were in 2015-2017.

* This was statistically significant for 2017 (p=0.041).

Riverfly species loss

The above results show that invertebrate communities are more stressed from chemicals now than they were in previous years. This strongly suggests the problem is getting worse. But the level of chemical stress on its own doesn't tell us what is happening to biodiversity.

Species loss in any ecosystem is a sign of distress. Changes in invertebrate diversity and abundance will alter the natural balance of river systems. This has implications for other species, like birds and fish which rely on invertebrates as a food source.

EPT stands for Ephemeroptera, Plecoptera and Trichoptera. These are orders of aquatic invertebrates better known as mayflies, stoneflies and caddisflies. As a general rule 20 or more EPT species in a sample indicates high water quality. A variety of EPT species, rather than just a high abundance of one or two species, is what we're looking for in a healthy system.

The Riverfly Census looked at the number of EPT species present across all the sample sites per year. For spring samples, 2015 had the greatest number of species, with an average of 18 different species. This number went down at each of the subsequent survey years – to a significantly lower 15 species in 2021.

For autumn samples, 2016 had the greatest average number of species with 13 different species. 2017 and 2021 were significantly lower with just 11 and 10 species respectively.

So, in addition to greater chemical stress being indicated, the diversity of key invertebrate species also appears to be decreasing.

Why do riverflies matter?

Most freshwater animals are invertebrates. In the UK over 4,100 invertebrate species spend at least part of their lifecycle in freshwater. These species play a vital role in maintaining clean water, recycling organic matter, and providing a food source for fish, birds, and mammals. Without invertebrates, the food web would collapse.

Freshwater invertebrates, like terrestrial species, are experiencing habitat loss, continually constrained to live in smaller areas. Freshwaters are haemorrhaging biological diversity faster than any other ecosystem on Earth. Freshwater invertebrates face many threats including:

- Reduced and altered water flows from abstraction and man-made barriers
- Nutrient enrichment from increased sewage discharges and agricultural runoff
- Acidification caused by atmospheric changes
- Loss of aquatic and bankside vegetation
- Artificial light and polarisation causing disorientation in adult riverflies attracting them away from their natural habitat
- Increasing temperatures caused by climate change
- Chemical pollution, including pesticides, pharmaceuticals, veterinary medicines, and PFASs

Chemical pollution is a particular problem for water quality, and its impacts are exacerbated by other pressures such as climate change. Despite the introduction of legislative mechanisms to protect water quality, these measures are not effectively implemented, monitored, or enforced. Rivers across the UK continue to suffer from chronic chemical pollution leading to long-term negative impacts on freshwater organisms.

Invertebrates are an important link in the food web as they convert the energy in plant and other organic matter into food for larger species such as fish, birds, and mammals. A loss of riverfly abundance can lead to stresses on other freshwater species. Riverflies can make up the primary source of food for some fish, particularly in upland habitats, however fish diets are often varied with other food sources available.

More than 280 species of mayflies, caddisflies and stoneflies are present in Britain. There are 24 species that are classified as threatened, and a further four species that are considered extinct in the UK. We also have several species that are endemic, found nowhere else in the world, including the following species:

Northern February red (*Brachyptera putata*): a stonefly that occurs only in Britain. It is found mainly in Scottish upland streams.

Scarce grey flag (*Hydropsyche bulgaromanorum*): a large caddisfly only known from stony areas on the River Arun in Sussex. This species is classified as Critically Endangered.

Yellow mayfly (*Potamanthus luteus*): an attractive, bright yellow mayfly that is found mainly on the River Wye in the Welsh borders and in the River Severn. It is classified as Endangered.

SmartRivers

WildFish manage a project called SmartRivers. This is the citizen science 'sister' of the Riverfly Census. Being a professional-led research study, from a logistical perspective the Riverfly Census is only able to cover a small number of our rivers. SmartRivers enables volunteer hubs, supported by a certified training scheme, to sample and analyse invertebrates to a near-professional standard.

Volunteer groups are trained to take samples and identify invertebrates relevant to their river. They can also send samples away for professional analysis. The species lists are entered into an open-access database. From this, the same water quality scorecards as the Riverfly Census are produced – including chemical pressure scores like the ones used in this report.

With SmartRivers we can understand even more about the health of our rivers, and people can get involved. So far:

- 24 volunteer hubs have enrolled, across England, Scotland and Wales
- 145 sites are currently in operation
- 86 volunteers were trained in 2021
- 212 water quality profiles were produced in 2021

River Avon case study

On the River Avon, Wiltshire Fisheries Association have continued the Census monitoring via our SmartRivers programme. They now survey the original Census sites, plus six more**.** The data has shown a dramatic fall in numbers of invertebrates within the last five years and concerning SPEAR signatures.

The Avon catchment is mainly made of rare chalk streams and is a Site of Special Scientific Interest (SSSI) and a Special Area of Conservation (SAC) as defined by the Water Quality Directive. In a very short time, it has fallen from one of the highest quality UK rivers, with abundant river life, to being defined by the Environment Agency as 'moderate' with a rapidly declining invertebrate population.

The Avon rises on the Salisbury Plain and flows into the English Channel at Christchurch. Within the catchment are several major tributaries - The Nadder, Wylye, Ebble, Bourne and Stour. The Avon catchment is believed to hold the largest number of different indigenous species of fish, more than any other river catchment in the British Isles, including the iconic and in decline Atlantic salmon.

The Avon's deteriorating water quality, like most catchments, is due to a myriad of pressures and is exacerbated by extensive population growth and housing development, including:

- agricultural runoff and fish farms which are elevating phosphates, nitrates and pesticides entering the river
- water abstraction
- Sewage Treatment Works, of which there are 13 on the Avon and its tributaries.

David Holroyd from Wiltshire Fisheries Association said *'The EA [Environment Agency] no longer has sufficient resources to effectively monitor water quality. To address these challenges the water quality monitoring is now largely undertaken by anglers and volunteers who undertake monthly samples of the invertebrate life in the river. Our frustration is that even when presented with the scientific evidence of this dramatic fall in the water quality and river life which has occurred over the last five years the EA still fail to take action. To succeed, it needs government leadership and a holistic improvement plan involving Wessex Water and the farming community. Together, we can and must urgently take action to stem this decline in one of the most important rivers in the British Isles'.*

Care about your river – set up a SmartRivers hub: To find out more contact: **smartrivers@wildfish.org**

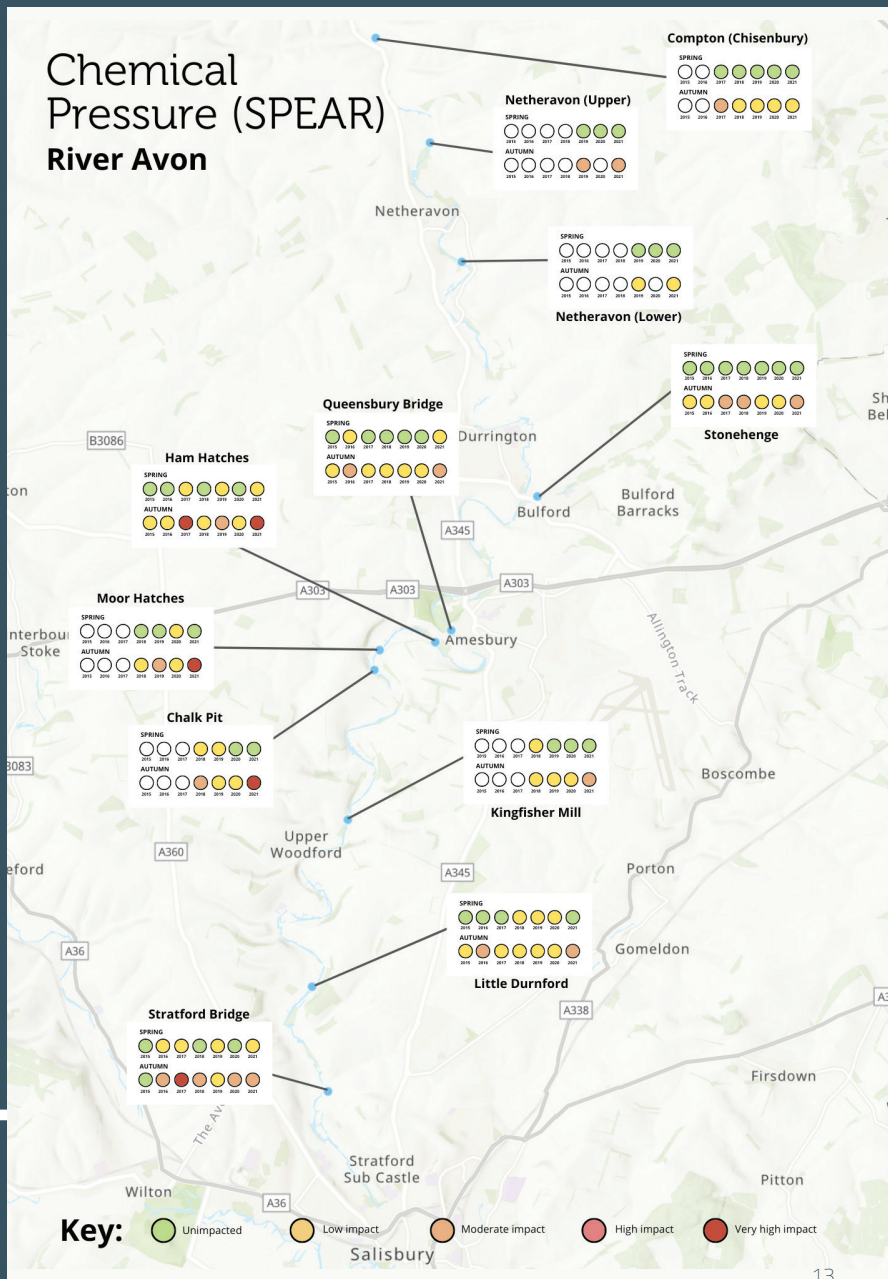


Figure 2: Impact of chemical pressure on riverflies at each of the River Avon sampling points in spring and in autumn, from 2015 to 2021.

What can be done?

Rivers and the wildlife that they support are facing a multitude of threats – a death by thousand cuts. Everyone can play their part, for example by correctly disposing of chemicals, by not putting anything down the sink or toilet that shouldn't be there and by not allowing pets who have just received flea treatment to swim in rivers. However, the big changes required to save our rivers will rely on Government action.

Recommendations for the UK Government

Point discharges from wastewater treatment plants are recognised as the dominant route by which pharmaceuticals enter the aquatic environment. However, concentrations of pharmaceuticals in rivers are usually lower than those of pesticides[13], which mainly originate from agricultural activities.

One of the key solutions to address the water quality crisis is tackling the pollution that comes from agricultural sources - 40% of waterbodies are failing to achieve good status because of agriculture. There are some important actions the Government could take to address this specific issue:

- Many farmers are turning to nature as part of a regenerative agricultural system. Government should use the opportunity of the development of the new Environmental Land Management Schemes (ELMS) in England to better support farmers to reduce their reliance on pesticides and artificial fertilisers. Ensuring that there is a diversity of crops across the farm and within the fields reduces the build up of pests and diseases. Maintaining healthy soils improves the resilience of the crops. And providing habitat for beneficial insects reduces the need for pesticides. All of these are actions that can be supported financially, and by better advice and access to information.
- More investment in non-chemical alternatives including research. New technology is often hailed as the thing that will solve everything. There is no doubt that technology can play an important role in reducing our reliance on artificial inputs in agriculture, but it is important we also recognise the value of nature as our ally and increase investment into more natural alternatives.
- Enforce existing farming regulations designed to protect rivers by agricultural diffuse pollution, such as **Farming Rules for Water**.

Other recommendations for addressing chemical pollution are:

- The UK Government is currently writing a Chemicals Strategy. This is an opportunity to be bold and ambitious in tackling chemical pollution across the UK. Many UK charities across the environment and human health have signed up to **12 key asks** that should be included in the strategy. These include:
  - » The importance of maintaining the Precautionary Principle – which states that a precautionary approach must be taken to chemical use unless science is very clear it is safe.
  - » Phasing out non-essential use of chemicals, and more hazardous chemicals
  - » Addressing the 'cocktail effect' – or the combined exposure of multiple different chemicals and the impact that has on the environment and human health
- Properly mandate and resource a comprehensive river monitoring network
  - » Despite the evidence that our rivers are in crisis, the coverage, resolution and frequency of national monitoring regimes continues to decline. Without a strong data baseline, it is extremely difficult to determine the long-term impacts of the pressures plaguing our watercourses or to confidently measure the success of actions undertaken to improve them. Projects like SmartRivers and the Riverfly Census are helping to fill the 'data gap, but we need the government to do more.
- Improve gaps in the risk assessment for chemicals before they are approved, and carry out retrospective assessments on chemicals already in use to better understand the real world impacts.

Conclusion

Evidence is clear that our freshwater habitats are suffering. Stopping pollution at source is better than removing it once it's there – in other words, prevention is better than cure. This means reducing reliance on chemicals in general, but also having sufficient enforcement so that it acts as a deterrent to would-be polluters. Not least, because the cost of cleaning up our rivers is eye-watering. Costs arising from the contamination of drinking water just with pesticides in the UK, has previously been calculated at £120 million per year[14]. We are in a biodiversity crisis, and we must urgently reverse this. The future depends on it.

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Mayfly rising from River Stour.
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Friesian cattle cooling off in a stream.
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p4
Fish die due to water pollution.
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Humpback whale, *Megaptera novaeangliae.*
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European otter, *Lutra lutra*.
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p5
Grey heron, *Ardea cinerea.*
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White-tailed bumblebee, *Bombus lucorum.*
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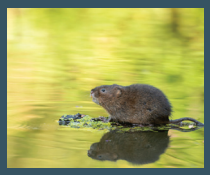

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Water vole, *Arvicola amphibius*.
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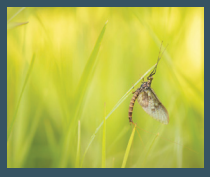

p6
Common mayfly, *Ephemera danica*.
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p7
River Avon, Bristol.
Becky Joynt

p8
Degraded river bed.
WildFish

p9
Stonefly on riverbed.
Jack Perks

p9
Grey heron on fallen tree.
Ben Andrew (rspb-images.com)

p10
Caddisfly *Trichoptera* larvae
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Southern iron blue mayfly, *Baetis niger*.
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Female scarce grey flag, *Hydropsyche bulgaromanorum*.
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Female northern February red *Brachyptera putata*.
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SmartRivers volunteers.
Lauren Harley, WildFish

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Atlantic salmon, *Salmo salar.*
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Egret *Bubulcus ibis* adult feeding amongst cows.
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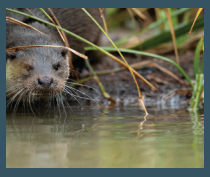

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European otter foraging.
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Rushing Naddle Beck, Naddle Farm, RSPB Haweswater Nature Reserve.
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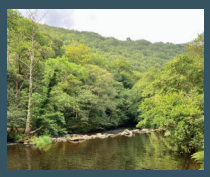

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River Teign, Dartmoor.
Myles Christopher

Chemical Pollution

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