FRESHWATER BIOLOGICAL ASSOCIATION

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Pet treatments could be harming freshwater life

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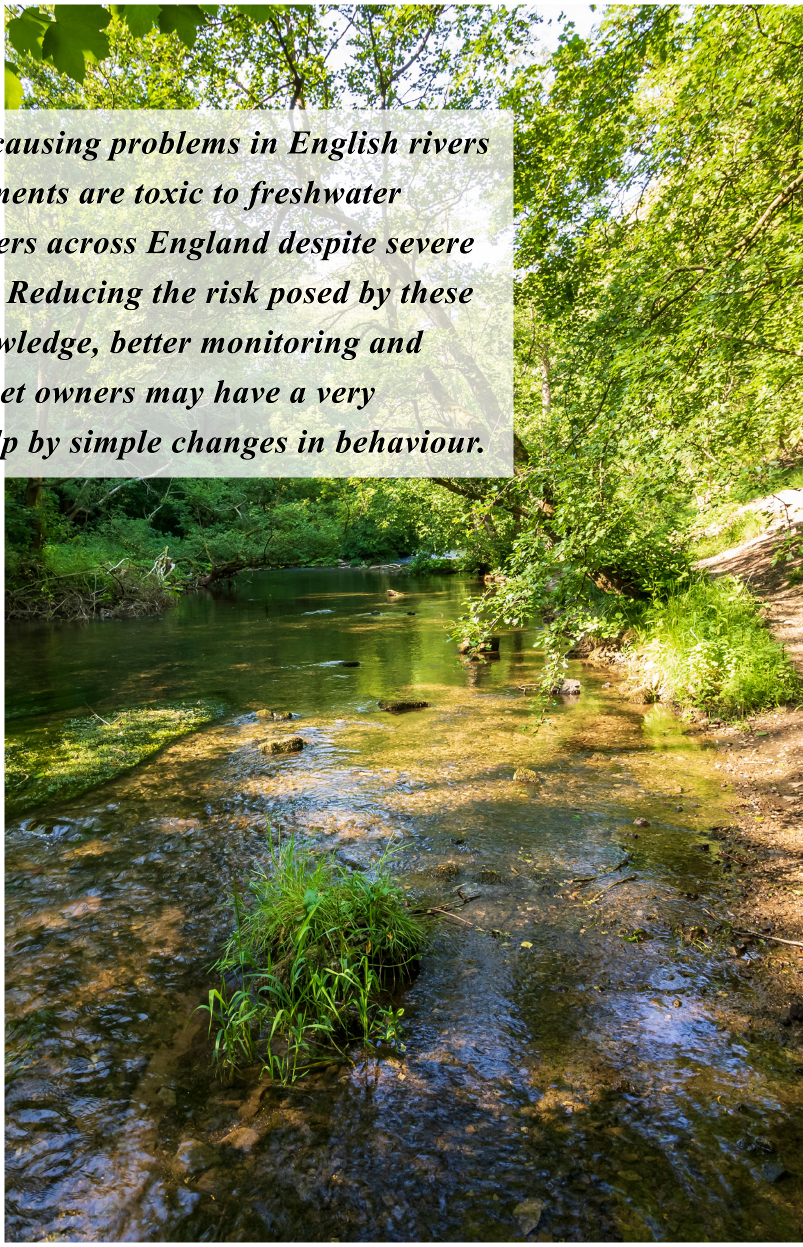

The use of flea treatment on pets could be causing problems in English rivers and lakes. The chemicals used in the treatments are toxic to freshwater invertebrates and have been detected in rivers across England despite severe restrictions on agricultural use since 2018. Reducing the risk posed by these chemicals requires improved scientific knowledge, better monitoring and stricter regulatory management. Vets and pet owners may have a very important part to play because they can help by simple changes in behaviour.

Background

UK freshwater habitats represent areas of high biodiversity that provide essential ecosystem services for provision of drinking water, food production and flood prevention. It is vital we protect them from the most harmful of human impacts[1,2]. Chemical pesticides - insecticides in particular - that are harmful to ecosystems are often detected in rivers across England. Two of the most frequently used chemicals in pet flea treatments - imidacloprid and fipronil - were found in 66% and 99% of samples from 20 English rivers between 2016 and 2018, respectively[3]; this, despite both chemicals being banned for outdoor agricultural use by 2018[4,5] and no recorded usage since 2016[6]. However, they are still widely used in pet treatments. Environment Agency monitoring of English rivers shows that these chemicals are still frequently detected despite the large-scale reduction in agricultural use*. For instance, recent research suggests that the principal source of river contamination from imidacloprid may now be from pet treatments[3,7,8] (Fig. 1).

* Northern Ireland, Scotland and Wales each have their own separate water monitoring agencies; this article focuses on England as a case study.

A brief history of pesticides and current environmental contamination

Pesticides have been used on an industrial scale worldwide since the 1960s, mainly in agriculture to suppress or eradicate invertebrate populations that reduce crop yield, or which are hosts or vectors of disease[10,11]. There are often, however, unintended detrimental consequences for non-target species[12]. Chemicals such as dichlorodiphenyltrichloroethane (DDT) and dieldrin (used as 'sheep dip') were some of the first to gain widespread notoriety for their devastating impact on natural ecosystems and, in some instances, their effect on human health[13]. These chemicals were subsequently banned in many countries during the 1970s and 1980s[14-16]. More recently, many of the subsequent generations of chemicals, such as imidacloprid and fipronil, have also been identified as having potentially harmful impacts in natural ecosystems. These two chemicals in particular have been at least partially implicated in global declines of bee populations[17-19], and they are also toxic to many other non-target species of invertebrates, as well as birds, fish and other vertebrates[20]. Both have since been banned from outdoor agricultural use in the European Union[4,5] and the UK, but these and other chemicals are still used in large quantities as veterinary pesticides (Figs. 2 & 3), including a broad range of parasiticide products used to prevent or treat parasite infestations in pets[21]. Tick and flea infestations in pets can also increase

> *Chemical pesticides - insecticides in particular - that are harmful to ecosystems are often detected in rivers across England*

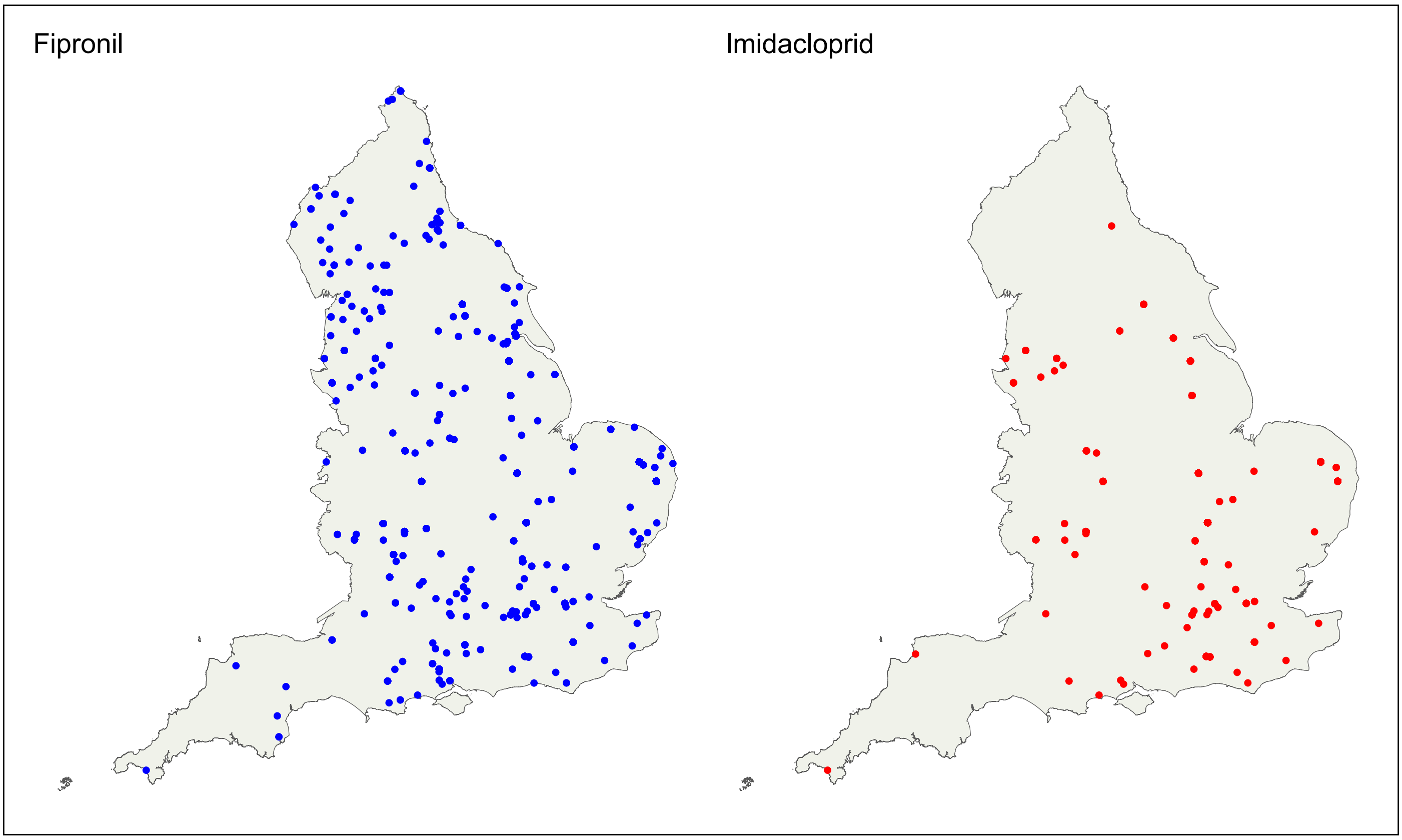

Figure 1: Distribution of fipronil (blue) and imidacloprid (red) at potentially harmful concentrations in rivers across England. The points are sites in English rivers at which fipronil and imidacloprid were detected in excess of their respective freshwater predicted no-effect concentration (PNEC) values from liquid chromatography mass spectrometry (LC-MS) analysis between 2016-2022[7]. The PNEC in fresh water for fipronil is 0.77 ng/L and 13 ng/L for imidacloprid[9]. Between 2016 and 2021, 121 and 64 out of 284 total sites sampled had concentrations of fipronil and imidacloprid exceeding their respective PNEC values.

the potential for human infections, for example of Cat Scratch Disease (*Bartonella henselae*)[22, 23], although instances of transmission from pets are generally considered rare, with no recorded cases of Bartonellosis reported in the UK in 2022 or between January and June 2023 (latest published reports)[24-27]. The chemical treatments used are compounds that are designed to be highly toxic to the target organisms at low concentrations, which is why they are so effective when used to control pests and parasites[8], but it also means they can be harmful to certain wildlife if they end up in natural ecosystems.

Following restrictions on agricultural practices in 2018, veterinary parasiticides in waste water pathways have been implicated as a potentially important source of the current presence of fipronil and imidacloprid in surface waters[3,32,33]. 'Down-the-drain' passage following spot-on application to pets has recently been confirmed as a viable pathway[34,35]. Another potential contamination route is via freshly treated pets swimming in water or excreting near a water course (Fig. 4). Despite improvements in the environmental monitoring of these chemicals, sampling effort remains limited: in 2021, of the 426 routine water samples collected across England for LC-MS analysis, only 40% were tested for imidacloprid, yet over half of those had detectable levels of the compound[7]. The presence of these chemicals is worrying as they have the potential to cause detrimental effects once they enter freshwater habitats, irrespective of whether they were originally used on pets or in agriculture[36,37].

Box 1

Common Types and Usages of Veterinary Parasiticides *(Sales values taken from a Freedom of Information request to the Veterinary Medicines Directorate 2022)*

- **Imidacloprid** is a neonicotinoid insecticide that affects the nicotinic acetylcholine receptor (nAChR) of blood-sucking insects and fleas[28]. Over 4,200 kg was sold in the UK in 2017.
- **Fipronil** is a phenylpyrazole parasiticide that disrupts the central nervous system of fleas and ticks[29]. Over 1,800 kg was sold in the UK in 2017.
- **Fluralaner** is an isoxazoline acaricide and insecticide that inhibits the function of nerve receptors in fleas and ticks[30]. Over 1,500 kg was sold in the UK in 2017.
- **Flumethrin** is a pyrethroid ectoparasiticide that alters the nerve functioning of fleas, ticks, and lice[31]. Over 300 kg was sold in the UK in 2017.

Potential ecological impacts

Finding veterinary parasiticides in freshwater ecosystems is a concern, largely due to the harm they might do to vulnerable non-target species[3,38-41]. Fresh waters depend on

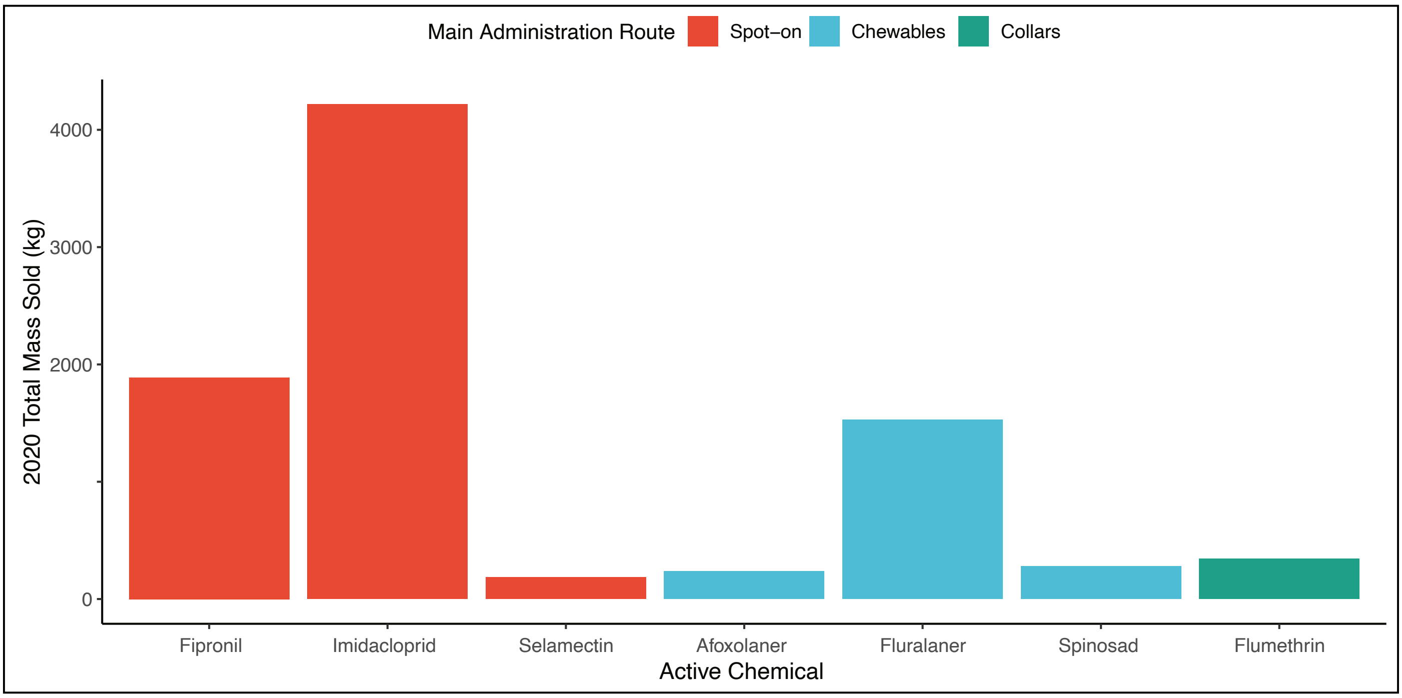

Figure 2: Seven of the most commonly used parasiticides in the UK and their main application method in 2020 (Veterinary Medicines Directorate (VMD) Freedom of Information request, 2022).

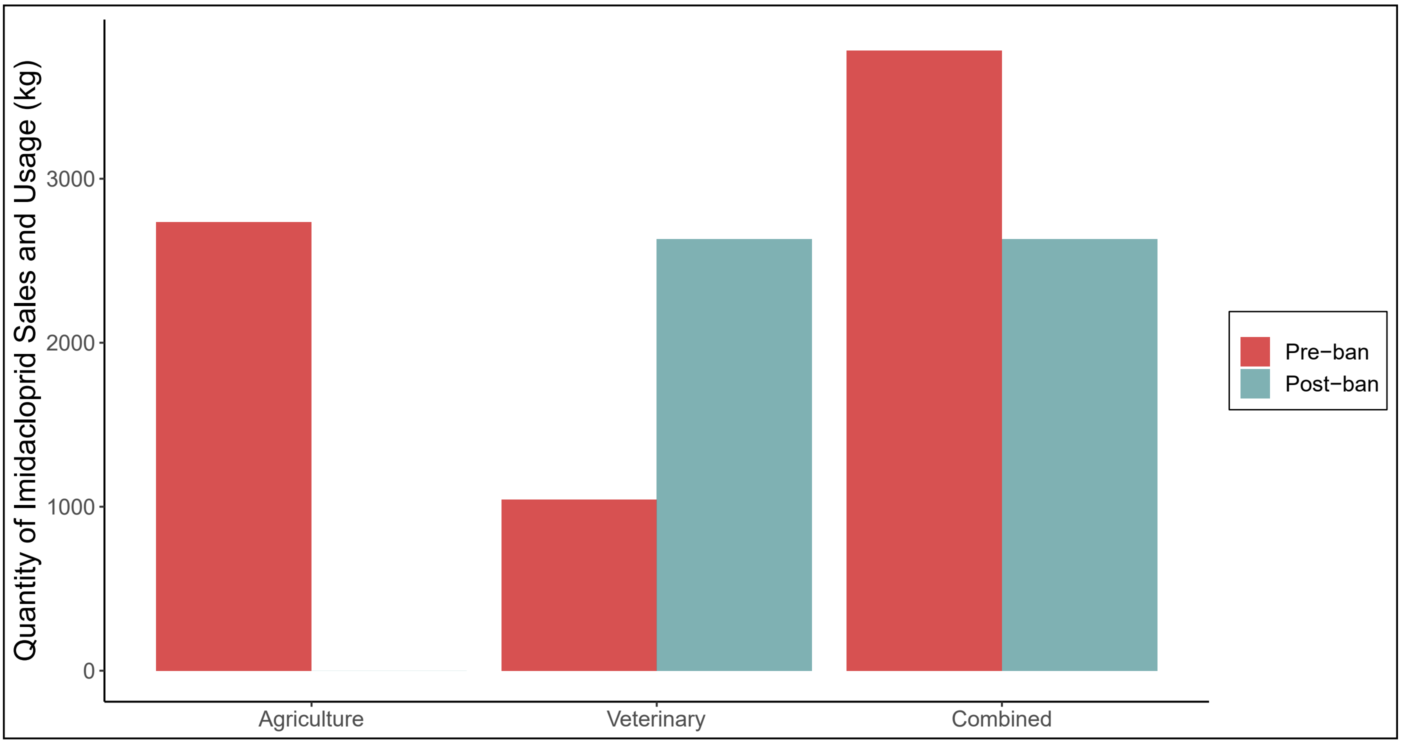

Figure 3: Patterns of imidacloprid usage in UK agriculture and total sales in domestic veterinary pet parasiticide products before and after the 2018 ban on outdoor use in the European Union[4]. The 'pre-ban' data is taken from 2009 and 'post-ban' from 2019. Volume of agricultural usage of imidacloprid was obtained from the Food and Environment Research Agency[6]. As not all crop types are surveyed each year, it is not possible to plot the total usage in any individual year but the figures provided give an indication of usage patterns over time. Arable crops, which had the largest agricultural usage, were not surveyed in 2009, meaning that actual usage may have been greater. Data obtained from the Veterinary Medicines Directorate (VMD Freedom of Information request, 2022).

invertebrates for a range of ecosystem processes and services, including nutrient cycling, which are critical for preserving ecosystem health[42]. These species are also food sources for many fish, amphibians, and other predators, so impacts on these assemblages could ripple through the food web and the whole ecosystem[43]. The wider ecological impacts of veterinary parasiticides remain under-explored, although an increasing number of studies point to their potential to harm aquatic communities[8]. Research suggests that exposure to concentrations equivalent to less than a teaspoon of either imidacloprid or fipronil in an Olympic-sized swimming pool can reduce richness and abundance, cause downstream drift, and increase mortality in key invertebrate species[37,38,44-47]. Parasiticides can affect ecosystems in a number of different ways, ranging from direct and acute toxicity, where they can be lethal to certain species from just a single exposure event, to often more subtle chronic toxic effects that may impair feeding behaviour, growth or reproduction over longer time scales[48-50]. Both can harm the wider ecosystem due to knock-on or cascading effects through the food web, which may persist even long after the chemical pollutant itself[51-53]. If we are to protect and manage freshwater ecosystems more effectively, we need to understand how the effects of such chemicals move through food webs in space and time and whether the risks they pose may be exacerbated in combination with other types of pollution or amplified by climate change. In the absence of this more complete understanding, caution should be exercised in the use of highly toxic chemicals that can spill into our natural ecosystems.

Patterns of parasiticide use

To give a sense of scale to the potential problem of parasiticide pollution, there are about 23 million dogs and cats in the UK[54]. It is common practice among many veterinary practitioners to prescribe preventative treatment to reduce the risk of parasite infection, often in the absence of clinical evidence of parasites in, or on, the animal[55,56]. Moreover, many treatments containing insecticides are freely available for purchase without prescription, supporting regular prophylactic use as recommended by the manufacturers.

The British Veterinary Association now advises against blanket treatment in favour of risk assessment and/or testing[56]. However, the lack of robust data surrounding incidence and health impacts of pet-borne parasites on dogs, cats and people[57-59] means there is little agreement on how to assess the health risks associated with the presence of parasites. There is currently limited supervision over the number of treatments sold to pet owners, or whether the correct chemical and dose are used, as no prescription is required to obtain many of these products[56,60-62]. Though the quantity used for each application is small (only 40 to 400 mg[63]) the widespread use, given the millions of pets that reside in the UK, can lead to substantial total usage volumes (Figs. 2 & 3).

Future regulation and research

Given the irrefutable evidence of ongoing contamination of fresh waters in England and associated potential for ecological harm, there is a strong case for a comprehensive review of how pet parasiticide chemicals are used and regulated[64]. Recommendations for parasite

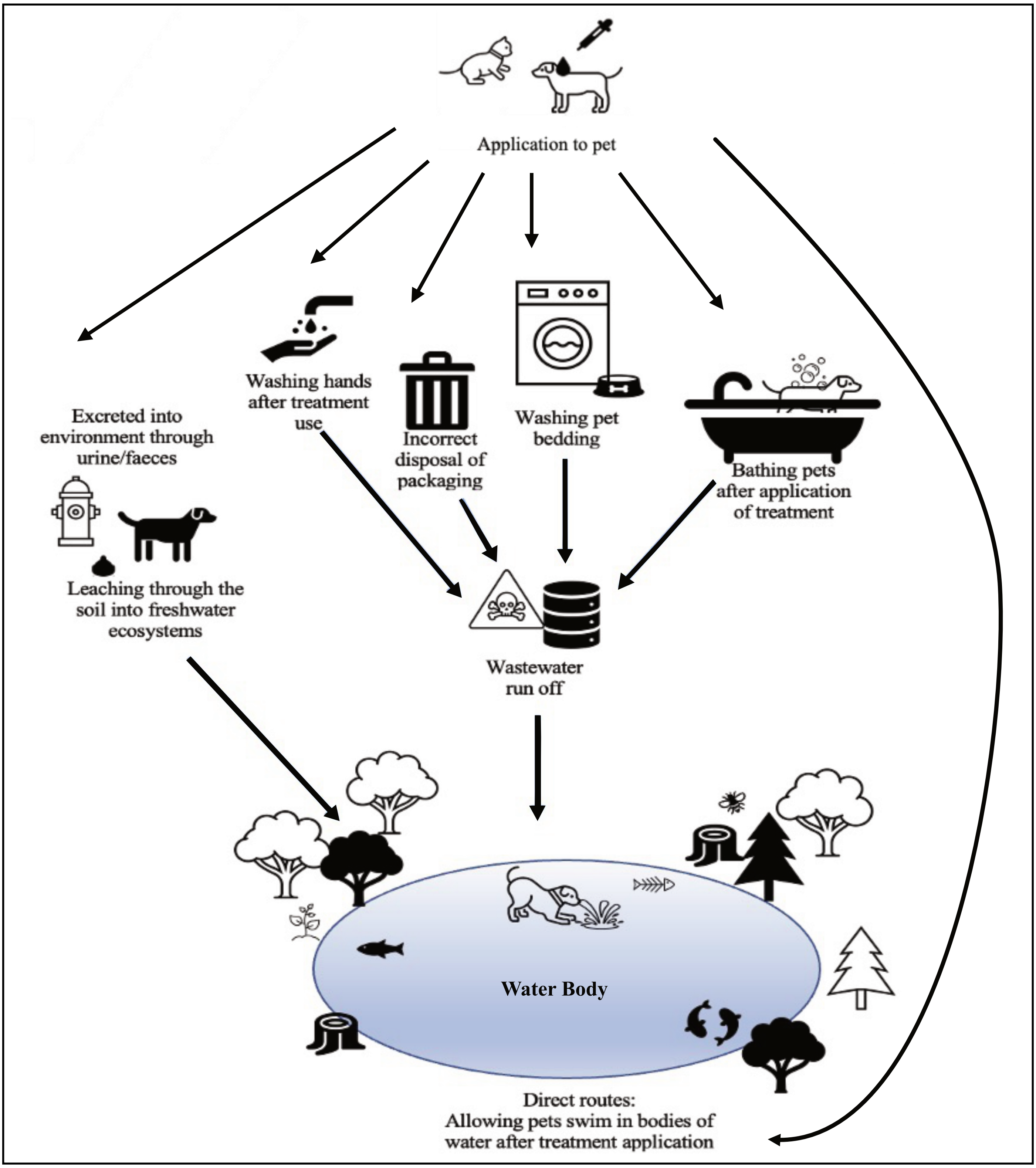

Figure 4: Potential routes by which pet parasiticides could enter ponds, lakes and rivers.

treatments should continue to discourage prophylactic 'blanket' treatment and consider how factors such as pet lifestyle (e.g., urban or rural, free-roaming or housed), and seasonal variation in parasite risk could be used to reduce the chances of environmental harm, advising more proportionate, better targeted treatment[56]. There is a case for considering whether over-the-counter access to such treatments should be restricted, with a full explanation provided by an awareness campaign, endorsed by veterinary practitioners. Aside from the risks to the environment from unintended exposure, reducing unnecessary usage would reduce costs for the pet-owner and could help to limit the development of resistance, a problem now well recognised with antibiotics and pesticides in general and with parasiticides in horses and livestock in particular[65,66]. It is also important to ensure that appropriate regulatory protocols are developed and implemented for the next generation of parasiticides that come to market, especially if we are to avoid simply repeating the mistakes of the past but with a new suite of chemicals.

It is likely that parasiticide treatment sales are at least partially driven by marketing, much of which focuses on how the products help to prevent or deal with the health risks associated with parasites[54]. However, there is a dearth of evidence surrounding the incidence rates of parasite-related disease in humans and pets in the UK[56-58]. Further research is needed to quantify this risk and identify appropriate and proportionate mitigation strategies[67,68]. This, combined with the pressing environmental threat, means that there is insufficient evidence-based justification for the large volume of veterinary parasite treatments sold and used on an annual basis (Fig. 2). Advertisement of veterinary prescription-only medicines is restricted exclusively to professionals, but parasiticides with less stringent prescribing restrictions may be advertised more widely[56]. A regulatory change to make all veterinary parasiticides prescription-only might reduce use but would be difficult to achieve in practice without support from veterinary professionals and manufacturers. Discouraging or stopping monthly subscription parasiticide schemes altogether, in favour of more targeted risk-based treatments might be a more effective approach of reducing environmental residues, whilst maintaining pet and human health.

Further research is needed to improve our understanding of the precise origin and the full scope of ecological impacts of these chemicals in UK fresh waters, from genes to entire ecosystems[69]. If domestic dosing of pets is indeed confirmed as a major source, a review of current regulations and policy could help to mitigate future impacts on our natural ecosystems. Research should focus on identifying optimal usage for maintaining both human and pet health, whilst minimising environmental impact. This is a major challenge but one that needs to be grasped urgently to ensure that there is a strong and reliable evidence base on which to base future actions and potential regulatory change, both within and beyond the UK.

Box 2

Actions that pet owners can take to reduce the environmental impact of pet parasiticides:

- Check your pets regularly for parasites and ask your vet clinic for help with assessing the risk for them.
- Consider only treating parasites if there is clear evidence of a high risk of infection or risk to the health of your pets or the people around them.
- Be very careful with applying liquid spot-on treatments: it is easy to spill some liquid on your hands without realising. Do not touch your pet until the product is dry and be aware that traces of topical parasiticides may continue to transfer to your hands and clothes for days or weeks after application.
- Consider not using topically applied products (spot-ons or collars) on dogs that swim or are bathed regularly.
- Do not flush waste medicines, faeces, litter material or cleaning waste from treated pets down the toilet. Ask your vet to put any contaminated packs or empty liquid vials in their waste medicine disposal bins[69].
- Ask your vets about the environmental risks of the products they recommend and check the labels on any parasite treatments for information about the ecological impact of residues. Try to avoid products that are either known to be hazardous or make no mention of risk.

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FRESHWATER BIOLOGICAL ASSOCIATION

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The Freshwater Biological Association is dedicated to understanding and conserving fresh waters across the globe. We have been advancing freshwater science and conservation action since 1929, to protect our global fresh waters by delivering and enabling freshwater science, conservation action, advocacy and learning.

We are advocates for urgent action to conserve fresh waters, which are some of the most vulnerable ecosystems on the planet. Leading by example, we are growing our role and impact through targeted and action-focused freshwater science, advocacy and learning, for the benefit of people and nature.

Our Association has the knowledge and data to drive positive action. We make a measurable impact on the ground through our science-based projects, species recovery programmes and citizen science activities. We train and educate freshwater scientists, building a community to protect freshwater habitats.

Our members and Fellows are at the heart of our Association, working collectively to shape the scientific agenda, influence policy and to deliver tangible change.

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