Written evidence from Producing Rational Evidence for Parasiticide Prescription (PREPP) group (PPM0006)

Imperial College London: Evidence submission to the inquiry into Pet Parasite Medication (May 2026)

Who we are

This response has been developed by researchers from the PREPP group (Producing Rational Evidence for Parasiticide Prescription) at Imperial College London. The PREPP group is a multidisciplinary partnership which brings together experts from within and outside of Imperial including ecologists, ecotoxicologists, environmental scientists and veterinary professionals. As part of wider research into chemicals in the environment, PREPP's work explores and evaluates the environmental risks posed by veterinary medicine pollution to gauge ecological impacts and to explore possible solutions. The group is supported by the Grantham Institute, Climate Change and the Environment at Imperial.

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1. **What are the main pet parasiticides of concern?**

The biggest selling pet parasiticides are Fipronil, Imidacloprid & Fluralaner (Kynetec, 2025). Fipronil and imidacloprid are the parasiticides for which environmental emissions and risk have been most extensively studied. However, significant knowledge gaps remain for other parasiticides, notably the isoxazolines (e.g. fluralaner) which, like fipronil, are highly persistent PFAS compounds. Comparatively little research exists on the environmental emissions, exposure pathways, contamination profiles, or ecological risks of parasiticides besides fipronil and imidacloprid.

Why is there concern about the ecological impact of these substances?

These substances are powerful insecticides with long half-lives, so where residues are found in the environment, they can have a long duration of action against wild invertebrates. Half-lives can vary dramatically depending on the chemicals and compounds involved, the combination of environmental conditions (UV light, water availability and temperature often being especially important) and biotic processing (e.g. biotransformation by microbes). Chemicals like imidacloprid can persist in soils or freshwater sediments for weeks or months, and in the water column for days to weeks. Imidacloprid's impacts on individual organisms appear to be irreversible, and these can also accumulate over time, with the concentrations at which chronic effects are manifested often being markedly lower than those for acute effects (Gill et al 2012, Morissey et al., 2015 and references therein).

Some chemicals, such as fipronil and also the new generation of isoxazolines and bispyrazoles also contain PFAS components (i.e., 'forever chemicals'). Concerns have been raised around

the environmental and human health impacts of PFAS chemicals (e.g. Markowska-Buńka et al. 2026), not least regarding their ability to persist for considerably longer in the environment. Some of these substances are also far less water soluble than imidacloprid and as such could pose more of a threat to terrestrial ecosystems than to their aquatic counterparts, for instance if contaminated biosolids in sewage sludge from Wastewater Treatment Plants are applied to land (approximately 87 % of biosolids are spread on UK agricultural land currently).

Aside from increased persistence in the environment, such PFAS-containing substances are broadly toxic to insects and arachnids (not just ticks and fleas), as well as many other non-target organisms (e.g. see reviews by Morissey et al., 2015, Soria-Fregozo, 2026). Given their low water solubility, they are also likely to bioaccumulate, as has been shown in the cases of fipronil and fluralaner in microbes, fish and invertebrates, for example (Wang et al., 2023; Konwick et al., 2006; Jia et al., 2018), and can increase in toxicity over an individual organism's lifetime (e.g., Crayton et al., 2020). The process of bioaccumulation can substantially increase the likelihood of risk and harm where relevant chemicals are present in the environment.

The concentrations reported in UK freshwaters are of ecological concern: imidacloprid and fipronil, for instance, have been found at levels associated with some form of measurable biological harm, with

PNEC values (Predicted No-Effect Concentration) often being exceeded in these ecosystems for extended periods of time, suggesting a strong "topping-up effect" of year-round contamination (also referred to as "pseudo-persistence", even many years after the agricultural ban (e.g. Perkins et al., 2021; Egli et al., 2023; Hadley et al., 2026). For example in the River Lea in London in 2020, concentrations of imidacloprid were measured at ~37.5 times the current PNEC of 6.8 ng/L (Egli et al., 2023) and considered the highest risk of any compound found there at the time, measured at a concentration of 255 ng/L. There is also concern that as these chemicals degrade over time the products that they transform into in the wild can be even more toxic than the original parent compound. Some of these transformation products can be an entire order of magnitude more toxic, yet they remain poorly understood and are not part of the current formal risk assessment protocols for veterinary parasiticides (Tank et al., 2026). As such, many members of the natural biota could be exposed to both the parent contaminants and their derivatives throughout much or all of their life cycle, and there multiple potential entry points to the food web, both directly and indirectly (e.g. predators consuming contaminated prey) (Tassin de Montaigu 2026; Hadley et al., 2026).

What is the evidence for these impacts, including known scale, severity and impact on different species?

There are now plenty of laboratory and field studies that have documented impacts of imidacloprid and fipronil on a wide range of organisms spanning many branches of the 'Tree of Life' and different trophic levels within both terrestrial and aquatic food webs (e.g., see Morissey et al., 2015, Gill et al., 2016 for authoritative early reviews). These range from bacteria (Smith et al., 2024), through to insects and other invertebrates (Nyman et al., 2013; Hadley et al., 2026), and also vertebrates such as fishes, amphibians, mammals and birds (Iturburu et al., 2018; Islam et al., 2019; Crayton et al., 2020; Saka and Tada 2021; Zhang et al., 2025;). Some of these effects at lower concentrations may be sublethal and/or chronic, such that although they might not cause immediate large-scale fatalities, they can impair behaviour, growth and reproduction (Gill et al., 2012; Nyman et al., 2013; Agatz et al., 2014; Suzuki et al., 2021) and in more extreme cases acute mortality can occur (Saka and Tada 2021). These impacts can also ripple through the food web, such that even if predators are not necessarily impacted by direct toxicity, they can still suffer indirectly via a collapse in their major food sources – this is particularly concerning for fishes, whose diet is often largely or wholly based on invertebrates, of which insects represent a major component in freshwaters (Yamamuro et al., 2019; Naiel et al., 2020). For instance, brown trout and salmon in the UK rely heavily on freshwater insects, such as mayflies and caddisflies, taxa that are known to be especially sensitive to imidacloprid (e.g. Macaulay et al., 2020, 2021), so long-term insecticide contamination could potentially erode their core food supply.

In general, lab-based studies on individual focal 'model species' are still by far the most common means of assessing biological impacts, as they are relatively easy and cheap to run and provide high levels of control and replication (Morissey et al., 2015). In this case, identifying causal relationships through dose-response trials is relatively straightforward. These types of studies (e.g. LC50 trials) can provide the foundational evidence that these chemicals trigger harmful biological responses, so they are a necessary first step to identifying potential harm in the wider environment (Thunnnissen et al., 2020). However, caution should be exercised when extrapolating from the tiny subset of model species favoured in lab studies to the far great span of biodiversity in the field, as sensitivity can vary markedly among species and even life-stages within species: for instance, the zooplankter *Daphnia magna* is a common model invertebrate species in lab trials, yet it is among the most resistant to imidacloprids (Li et al., 2020), whereas other species that are common in the wild but rarely considered in the lab, such as mayflies can be many times more sensitive (Morissey et al., 2015; Islam et al 2019; Macaulay et al., 2020, 2021). As such, what holds for one species does not necessarily apply more generally (Morrissey et al., 2015). In addition, lab studies are unable to capture the full scope of potential direct and indirect effects in the wild as they typically only focus on not only a tiny number of species but they also rarely, if ever, consider species interactions (e.g. predator-prey or other types of feeding links) that can transmit impacts through the wider ecosystem. Nor do they typically consider potential longer term chronic effects that can emerge at much lower concentrations than those at which acute responses manifest (Li et al., 2025; Zhang et al., 2025). Some 'keystone species' that are important hubs within freshwater food webs, such as *Gammarus* shrimps, caddisflies and mayflies (all important diet items for trout and salmon and many other UK fishes), appear to be particularly sensitive to imidacloprid (Agatz et al 2014; Macaulay et al., 2021; Nyman et al., 2013), for example. As such, any negative impacts could in turn affect the ecosystem processes they drive and also the supply of food to their consumers at the higher trophic levels (e.g. fishes). There is growing evidence that pesticides in general can trigger indirect genes-to-ecosystems 'ecological surprises' in wild food webs that cannot be predicted from lab studies, such as biodiversity shifts and algal blooms and slowed decomposition rates associated with chlorpyrifos (a now-banned organophosphate insecticide) contamination in the River Kennet (Thompson et al., 2016; Andujar et al 2018).

Overall, the levels of contamination we are seeing in UK freshwaters raise concerns that these chemicals could be having meaningful biological impacts on individual species in the wild, based on responses seen in lab trials, and there is also concern that we are still only glimpsing a tiny part of a potentially much bigger picture in the field, as the longer term chronic effects and indirect food web responses are largely ignored and thus may be severely underestimated as a result (Li et al., 2025; Hadley et al., 2026). Some recent biomonitoring field data have confirmed concerning field concentrations and the presence of these chemicals in many non-target wild species such as birds' nests and eggs (Tassin-de-Montaigue 2026; Tank et al., 2026), often at concerning concentrations, for instance with PNEC values being exceeded by a significant margin in many cases (Egli et al., 2023; Hadley et al., 2026). Some of the more sophisticated next generation of larger-scale lab and field experiments to emerge in recent years have also started to reveal rippling impacts on entire freshwater food webs, and the potential for these effects to interact with other environmental stressors, including warming, microplastics, nutrients and other pollutants (Macaulay et al 2020, 2021; Zhang et al., 2025).

The big challenge now lies in fully characterising the link between the smaller-scale lab trials focused on a tiny subset of model species through to impacts on the wider spectrum of biodiversity under field conditions, where disentangling the signal from the noise is much harder due to the inherent (bio)complexity of such systems. At present, this field is still in its relative infancy, with much of the evidence to date still relying on extrapolations from lab studies and inference from correlational field studies, but given the wide range of observed and potential impacts that are now emerging and the huge scope for huge disparities in responses among taxa there is a compelling case to take a precautionary approach to assessing ecological impacts in the wild.

2. **How are the parasiticides of concern entering the environment? What are the primary distribution pathways in ecosystems?**

Research indicates that wastewater effluent is the primary pathway by which fipronil and imidacloprid enter UK waterways (Perkins et al., 2024; Hadley et al., 2026). Multiple down-the-drain emission routes have been identified for pets treated with spot-on formulations, including pet owner handwashing, pet bathing and bed washing, with little removal occurring through wastewater treatment (Perkins et al., 2024). Critically, these emissions persist for weeks post-application and arise through routine, correct product use - not misuse or mishandling. There is no strong evidence that non-compliance with datasheet guidance, whether through misapplication, incorrect use, or improper disposal, constitutes a significant pollution source. Consequently, mitigation strategies premised on promoting correct use of parasiticide treatments are unlikely to meaningfully reduce environmental contamination. The only intervention currently demonstrated to reduce pollution is a reduction in overall usage.

In 2018, the same year as the ban on outdoor agriculture use, members of the PREPP team conducted a detailed survey of five river catchments across rural Suffolk, a region of the UK particularly impacted by outdoor neonicotinoid pesticide use in agriculture, and found no occurrence of imidacloprid in either invertebrate or water samples indicating early evidence of abatement from the environment (Miller et al., 2019). In 2021, the team conducted a similar survey in the estuary of urban Colchester and found imidacloprid in samples of multiple different invertebrate species and in water, particularly downstream of a wastewater treatment facility (Miller et al., 2021). A detailed examination of the Environment Agency data since 2018 showed widespread occurrence of pet parasiticides in UK water bodies at a level considered to be of moderate to high risk to aquatic life, (Preston-Allen, et al., 2023; Environment Agency, 2024). Spurgeon et al. (2022) also ranked all chemicals reported by the Environment Agency, with fipronil ranking first in terms of environmental hazard in one subset of chemical analysis data for surface water and 14th highest for ground water, and in each case out of a total of 1,144 chemicals evaluated. The urban signature of pet parasiticides has become even more prevalent since 2018. In London from 2019-2021, members of the PREPP team conducted the most intensive study of chemical contamination in the waterways of any capital city globally and found statistically significant increases in the mean concentration of imidacloprid across 14 waterways to a high environmental risk level (note that fipronil was not included in this particular study). Imidacloprid was ranked highest of 21 compounds identified to pose a risk to aquatic life (Egli et al., 2023). Several follow-up studies have shown the risks of both imidacloprid and fipronil (Richardson et al., 2021, 2022) in urban waterways, especially to show that they were consistently detected inside several samples of invertebrates taken over a six-month intensive study in the River Wandle in London and that imidacloprid was the most toxic compound of all studied (Richardson et al., 2025). A national scale 'citizen science' programme in 2024 and 2025 led by Earthwatch Europe (2025) showed that imidacloprid was present at moderate to high risk levels across 100 locations, with data from >1400 sites pending completion in 2026, but with current indications that it was the highest risk compound of over 100 chemicals detected.

Many other reasons are offered for the occurrence of pet parasiticides in water bodies, including that the owners allow their pets to bathe in public spaces prematurely after treatment. The PREPP team has also conducted detailed studies in public parks (e.g. Hampstead Heath as just one example), where ponds designated for pet swimming were analysed (Yoder et al., 2024). While high concentrations of pet parasiticides were measured and correlated with the number of animals using these ponds, these were not shown to be a major source that would contaminate or pose a risk to the wider waterway network, mainly due to significant dilution downstream. We found this finding to be upheld in other studies of public parks in the UK.

For wider context beyond the UK, samples tested from three EU locations in the same laboratory (including several urban locations in Basel on the R. Rhine) showed no contamination with pet parasiticides (Egli et al., 2021) indicating that the scale of use of pet parasiticides that resulted in environmental occurrence may not be as widespread there as in the UK. That said, both fipronil and imidacloprid have been listed on EU Water Framework Directive Watch Lists of chemicals of emerging concern requiring deeper monitoring and environmental risk assessment (European Commission, 2026). In December 2025, the PREPP team presented this issue to the Parliamentary and Scientific Committee in the House of Lords (presentation here) and wrote an article summarising the issue for its journal Science in Parliament (Barron et al., 2025).

Aside from freshwater and estuarine habitats, in 2025, a collaboration between universities (including Imperial College) and local community groups in Portsmouth and Chichester showed that wastewater was contaminating coastal areas (Uhlhorn et al., 2025), which are generally expected to be up to 10-fold more sensitive to chemical pollution in particular than freshwater environments. It was found that imidacloprid was the highest risk chemical residue of >105 chemicals found in the water and was sourced to both untreated and treated sewage discharges. While some other chemicals increased or decreased in concentration when the dominant pollution signature changed from either source, imidacloprid concentrations remained constant, indicating that wastewater removal of this substance was inefficient. This was also shown in other research examining data from 12 UK wastewater treatment facilities monitored during the 3rd UK Chemical Investigations Programme (UK Water Industry Research, 2023) and where removal of both imidacloprid and fipronil was ineffective over more than a year (Aug 2020- Dec 2021) and with clearly elevated and consistent occurrence downstream of the treated wastewater discharge sites (Perkins et al., 2024). Hand/bedding washing as well as pet bathing was estimated to account for 20-40% of the wastewater contribution from these pet parasiticides.

Ongoing research (Collins et al., 2026 – pre-print) has investigated domestic exposure to imidacloprid in the home by measuring the presence of the chemical in dust, as well as floors and fabrics on which animals were frequently in contact. This research found that imidacloprid rapidly contaminated the homes, and that washoff from floors and fabrics contained concentrations far exceeding the environmental quality standards that exist. Seven days post-application, imidacloprid concentration in domestic mop water exceeded the acute toxicity maximum acceptable concentration (MAC) by 600-fold and rinsate from fabric on which animals frequently sat was almost 5000-fold the MAC. In a follow-up study comparing concentrations of imidacloprid in household dust across 50 properties, the ten properties without resident pets had measurable quantities of imidacloprid, but had the lowest concentration of all categories, and not statistically distinguishable from those who used oral administrations of imidacloprid (0.12-4.8 μg/g of dust). Households who had applied spot-on treatments were found to have considerably higher concentrations of imidacloprid in their dust (38 +/- 17 μg/g, p=0.0052). The same study is currently examining fipronil in these samples and will be completed later this year.

3. What possible alternatives are there to replace medications containing parasiticides of concern?

The first and most important alternative is to change from routine preventative treatment (blanket treatment) to more targeted, risk-based treatment, as advised by British veterinary associations (BVA, BSAVA & BVZSA., 2025). This could combine risk-stratified prevention -reserving prophylactic use for higher-risk scenarios with reactive treatment, whereby pets are monitored and treated only upon confirmed infestation. Alternative parasiticides to fipronil and imidacloprid include systemically acting isoxazolines such as fluralaner, (es)afoxalaner, lotilaner and sarolaner. Some, such as afoxalaner, are now available without a veterinary prescription as NFA-VPS products (sold by a veterinary, pharmacist of suitably qualified person). These are a newer class of systemic PFAS chemicals (also known as forever chemicals) that are available primarily in oral (tablet) and topical (spot-on) forms. We outline the potential risks of these alternatives below. Evidence from controlled trials in real-world household flea infestations demonstrates that modern systemic ectoparasiticides, particularly isoxazolines, resolve infestations rapidly and without recourse to household insecticide application (Dryden et al., 2016, 2017, 2018; Williams et al., 2014). This substantially undermines the rationale for routine flea prophylaxis, as is currently widely practiced.

Non-parasiticide treatment options are limited. Other proprietary repellents, herbal products or compounds such as diatomaceous earth are available but lack reliable data on efficacity.

In considering possible alternatives, it is also important to contextualise the risk. The current scale of preventative use of parasiticides far exceeds the frequency with which these ectoparasites - fleas and ticks - are found on cats and dogs. The largest published surveys of UK veterinary consultations identified fleas in 1 in 400 dogs, cats 1 in 85. Ticks: 1 in 150 dogs, and 1 in every 625 cats (Farrell et al., 2023; O'Neill et al., 2024; Arsevska et al., 2024). Given the low human health risk from pet-related fleas/ticks (as outlined below), our strong view is that moving away from prophylactic treatment is the most appropriate alternative.

What impacts might these alternative medications pose to the natural environment?

The environmental risks associated with alternative parasiticides such as isoxazolines are poorly understood and it is important to recognise that such alternatives may also pose an environmental risk. Due to the assumption of negligible environment exposure in the regulatory framework and the lack of Phase II environmental risk assessment, no information on the fate, ecotoxicity or impact of isoxazolines is required prior to regulatory approval. This may lead to 'regrettable substitution' where a replacement product may have similar or potentially worse consequences on the environment and health than the original chemical.

There are grounds for serious concern regarding the environmental risks posed by isoxazolines. Recent research has demonstrated prolonged faecal excretion at concentrations sufficient to pose a risk to non-target invertebrates (Berny et al., 2026). As systemically absorbed compounds, isoxazolines are also distributed to the skin and hair of treated animals (EMA, 2013) suggesting a further dissemination pathway through passive shedding. This is supported by empirical evidence: fluralaner has been detected at concerning concentrations in swimming water following entry of an orally (tablet) treated dog (Diepens et al., 2023).

There is also concern around human and environmental exposure to topically (spot-on) applied isoxazolines – for example, research indicates that only 25% of topically applied fluralaner is systemically absorbed and excreted in faeces (Kilp et al., 2016). The rest remains on the skin, and the ultimate fate of this remaining 75% remains unknown - raising concerns around human and environmental exposure to this highly persistent PFAS parasiticide, which is known to cross the mammalian blood-brain barrier and has not been approved for human use (Britti et al., 2026; Mccomic et al., 2026).

The introduction of perfluoroalkyl chemistry within the molecular design of several pesticides is now very frequent industrial practice, including to help increase their prophylaxis efficacy period (the length of time the chemicals continue to provide a preventative function before degrading). This has also appeared in pet parasiticide molecular design (e.g., fipronil). Importantly, to our knowledge, all of the new isoxazoline and bispyazole treatments for ticks and fleas contain PFAS functional groups and are available as spot-on treatments. Some of these claim longer efficacy from a single treatment up to 13 weeks post application (Décor et al., 2025) and are generally considered more potent than traditional treatments such as fipronil (Gassel et al., 2014).

Mitigating the environmental and human health impacts of per- and polyfluoralkyl substances (PFAS) is very much under significant public and regulatory scrutiny given their persistence, bioaccumulative properties and toxicity. PFAS comprise a large suite of thousands of chemicals and have been implicated in several health concerns, including suppressed immune system function, increased cholesterol, liver damage, developmental delays in children and cancers (kidney, testicular), thyroid dysfunction, and reduced fertility (further detail and references in section 4).

In 2026, the UK Government reviewed this evidence and published its plan for reducing the reliance on PFAS materials to build "a safer future together" (Defra, 2026). As one of five principles set out in section 17(5) of the Environment Act 2021, it states that it will take a precautionary principle-based approach to PFAS moving forward (Defra 2026). As part of this, the plan states, "*As a precautionary action to reduce potential risks from PFAS, industry and retailers should assess whether the use of PFAS is essential to achieve the desired function and should consider alternatives where possible*". To put this into context, members of the PREPP team recently showed that one of the traditionally presumed primary routes of PFAS exposure to humans (i.e., tap water) was unlikely (Richardson et al., 2026), but the team also showed that high concentrations of perfluorinated spot-on treatments were present on fabrics within UK homes as well as the hands of pet owners and comprised a major component of environmental pollution sources via 'down the drain' discharges arising from washing, cleaning as well as waste disposal (Perkins et al., 2024). The risks of short chain PFAS in particular is a current concern for public health and environmental protection. Short chain PFAS chemistry is used in several pesticides, including pet parasiticides. Together, pesticides and PFAS rank at the top in terms of concern in a recent report by Deep Science Ventures (https://www.deepscienceventures.com/toxicity) across all chemical types. This is particularly relevant to pet parasiticide treatments given their prevalence across a large proportion of UK households.

It is important to remember that these treatments are pesticides, designed to kill invertebrates, but that they are being marketed as medicines. While treatment may be appropriate in response to infestation, for both human and animal health reasons, preventative and consistent use on this scale is not underpinned by sufficient evidence of human zoonosis prevalence. Also, the incorporation of PFAS into these molecules for preventative use should be considered a 'non-essential use' of PFAS as is currently being considered by the European Chemicals Agency and the UK Government (Defra, 2026).

Aside from regrettable substitution, it is also important to recognise and consider evidence of 'greenwashing'. This is where a company may misleadingly state that a new product is 'greener' based on only partial consideration of all variables or without providing transparent proof. An example may be that smaller amounts of a new parasiticide need to be manufactured or used, inferring a “greener” more “efficient”, “sustainable” or “eco-friendly” profile, but actually, the molecule may be (a) designed to be more potent at lower doses, meaning it becomes significantly more challenging to measure and risk assess at relevant concentrations expected to have an impact in the environment and (b) incorporates other chemistry (such as PFAS discussed above) as an attempt to mask its wider risks in favour of highlighting its increased timeline of efficacy (Mencke et al., 2023) or convenience to the consumer.

A regrettable substitution by moving to new materials that incorporate PFAS can also have consequences for the treatment of contaminated water and land. While fipronil and imidacloprid are not well removed by wastewater treatment, new generation tick and flea treatments (isoxazolines and bispyrazoles), by design, are more likely to be bound to sewage sludge. As over 85 % of municipal sewage sludge is spread on agricultural land in the UK, the impact of such products on the agricultural soil environment therefore presents a risk, not only to invertebrates in general, but also could potentially represent a biosecurity risk to key pollinator species – one of the driving reasons to ban imidacloprid and fipronil from outdoor agriculture use in the first place. The risks of sludge spreading as a general practice is currently under review at DEFRA, especially regarding the impacts of PFAS-containing materials which are likely to accumulate in this material. Therefore, the precautionary principle should be adopted here before introducing new materials to the market that may have different or worse consequences to environmental health.

What is critical to emphasise is that we do not advocate for a ban on existing substances, but to primarily change the scale and mode of use, as well as their availability in line with the UK Environment Act. We set out ten practicable recommendations in our briefing paper (Preston-Allen et al., 2023) which do not only apply to traditional products like fipronil and imidacloprid, but all pet parasiticide treatments. The ten recommendations are as follows:

1. Require a full environmental risk assessment for pet parasiticides before approval.

2. Introduce review thresholds based on parasiticide sales volumes.

3. Review approvals where active ingredients are banned in other sectors.

4. Phase out active ingredients that fail risk standards.

5. Promote need-based prescribing over routine preventive use.

6. Review whether some parasiticides should be prescription-only.
7. Introduce safe disposal schemes for unused parasiticides.
8. Reduce sewage overflows by increasing treatment capacity.
9. Invest in new tertiary treatment approaches to remove residual contaminants.
10. Improve ecosystem resilience through catchment-scale restoration.

4. What are the potential human health risks of:

a. reducing pet parasite medication use and thus potentially increasing exposure to ticks and fleas

A central concern raised in opposition to more targeted prescribing is that reducing routine prophylactic treatment could increase human exposure to pet parasites and may result in significant increases in vector-borne disease (e.g. Wright, 2020). The available evidence does not strongly support this concern.

As these zoonotic infections are not notifiable, there is no central database to quantify infection rates (the risk) with any certainty. The data that is available from the NHS Hospital Diagnosis reports (NHS England, 2023-2025) suggests that the incidence of zoonotic infection remains low, to the point that none of the potential pet ectoparasite-associated zoonoses are currently listed on the Health Security Agency (HSA) or Animal and Plant Health Agency (APHA) zoonosis surveillance reports (UK Health Security Agency, 2025).

In terms of potential risks, Lyme disease is caused by the microorganism *Borrelia burgdorferi* carried by ticks, primarily the sheep tick *Ixodes ricinus*, which is also the commonest tick found on dogs and cats. 5.8% of sheep ticks caught in the wild carry *Borrelia* (Gandy et al., 2025), but for those found on cats and dogs the figure is 2% (Wright et al., 2018). There are no recorded cases of human infection with Lyme disease caught from their pets, but research in the US suggests that the chances of finding a tick either crawling on or attached to a human are around 1.5 times higher in pet owning homes compared to pet-free homes (Jones et al., 2020)

Bartonella species - the flea-borne bacteria responsible for bartonellosis in humans, though typically causing no symptoms in pets - are frequently cited in support of year-round flea treatment for cats and dogs in the UK (Wright, 2020). While one study found *Bartonella* spp. in 11.3% of flea infestations on pets, only 17 of the 53 *Bartonella*-

positive flea pools were identified as the specific species *B*. henselae - representing just 3.6% of the 470 flea samples tested (Abdullah et al., 2019). *B. henselae*, the causative agent of cat scratch disease and the species most commonly associated with zoonotic infection, was furthermore not assessed for whether the strains detected belonged to genotypes known to cause human disease.

In practice, reported human bartonellosis infections in the UK remain rare. This is likely because most cats carry *B. henselae* strains with low zoonotic potential (Chaloner et al., 2011), and because cat scratch disease in humans tends to be mild and self-resolving. Reflecting this, *B. henselae* infections are absent from the APHA's annual Zoonosis Report (APHA, 2024), reinforcing the view that flea-associated bartonellosis does not represent a substanitial public health concern. NHS England data - the most detailed picture available given the absence of formal surveillance or reporting - recorded just 10 and 11 hospitalised cases of cat scratch disease in 2021–22 and 2022–23 respectively (NHS England, 2023), figures consistent with the low incidence picture outlined above.

Despite widespread promotion of year-round prophylaxis by industry-affiliated bodies (see point 9), current uptake is incomplete: while over 80% of pet owners administered at least one ectoparasiticide treatment in the preceding year, only 31% did so year-round via a subscription scheme (Perkins et al., 2023). Full compliance with ESCCAP guidelines would entail an estimated 70% increase in parasiticide use (Giannelli et al., 2025).

That human health risks from pet-associated parasites remain low under this incomplete coverage suggests that a shift towards targeted, risk-based prescribing is unlikely to result in any meaningful increase in public health risk - and that current treatment levels may already exceed those necessary to maintain it.

b. of direct exposure to the pesticides?

Multiple studies have shown that chronic exposure to pesticides can be associated with adverse human health outcomes, ranging from fertility impacts to neurodevelopmental and neurodegenerative impacts (Yan et al., 2016; Li et al., 2025; Liu et al., 2026).

Both fipronil and imidacloprid have been associated with potential human health risks (Thompson *et al.*, 2020; Chen *et al.*, 2022; Leemans *et al.*, 2019). Of particular concern is their capacity to act as endocrine-disrupting chemicals (EDCs) - substances that interfere with hormone biosynthesis, metabolism or action, potentially causing adverse health effects even at very low doses. The health effects associated with EDC exposure span reproductive, neurological and developmental outcomes, amongst others (Kabir et al., 2015).

Within this context, a growing body of animal, in vitro and epidemiological evidence has identified fipronil - and specifically its primary metabolite, fipronil sulfone - as a potential thyroid-disrupting chemical. The epidemiological evidence, while limited in scope and largely cross-sectional, is consistent across independent cohorts and demonstrates detectable associations with thyroid disruption at background population exposure levels. Prenatal exposure is a particular concern, given the well-established sensitivity of foetal neurodevelopment to even brief periods of thyroid hormone disruption (Leemans et al., 2019; Morreale de Escobar et al., 2004).

A pregnancy-birth cohort study found that fipronil sulfone crosses the placenta and is detectable in newborns, with higher exposure levels associated with lower free T3 concentrations (an important thyroid hormone) in both cord blood and neonatal serum. Higher fipronil sulfone concentrations were also associated with poorer five-minute Apgar scores, a standard measure of newborn condition at birth that serves as a marker of developmental vulnerability (Kim et al., 2019).

Despite their widespread household use, pet parasiticides have received comparatively little attention in the human health risk literature. However, evidence of potential harm is beginning to emerge. A 2023 risk assessment by the California Environmental Protection Agency's Department of Pesticide Regulation concluded that that topical fipronil flea products - namely, sprays and spot-on treatments - posed a potential subchronic and chronic risk to human health, whilst dietary exposure to fipronil residues in food were not considered a health concern, (CEPA, 2023). Keil et al. (2014) found that children whose mothers reported using imidacloprid-based flea and tick products during pregnancy had elevated odds of an autism spectrum disorder (ASD) diagnosis, with the association strongest among frequent users. The authors acknowledged that this represents an association rather than established causation and called for further research.

More recently, Goodrich et al. (2025) reported that exposure to pet flea and tick products during pregnancy and early childhood was associated with lower cognitive and adaptive scores in children with ASD and developmental delay. While causation remains unproven, these findings are consistent with the broader literature on pesticide neurotoxicity and contribute to a mounting pattern of concern around pet parasiticide exposure specifically.

It is important to acknowledge that the regulator – the Veterinary Medicines Directorate (VMD) - conducts user safety assessments for these products and may cite these as evidence that human health risks are adequately managed. However, this position deserves scrutiny on several grounds:

First, the rigour of these assessments has varied considerably over time. User risk assessments for spot-on products were substantially updated in 2018. The revised guidance requires more comprehensive evaluation of user exposure and toxicological risk - reflecting a higher standard of scrutiny than had previously been applied (EMA, 2018). However, this was not applied retrospectively to existing products, or to generics (products with the same composition as existing products) approved after this date, leaving much of the existing market and the generic sector assessed to the pre-2018 standard. Instead, in many cases approval relies on limited and inconsistent user risk assessments that may not reflect current standards (EMA, 2014).

Secondly, publicly available detail on user risk assessments is often incomplete (eg. EMA, 2009; BVL, 2018), with little detail on exposure assessment or toxicological endpoints provided, preventing independent scrutiny of methodology, assumptions, and conclusions. Freedom of Information (FOI) requests seeking fuller disclosure on user risk assessments have been refused on the grounds of commercial sensitivity (VMD, 2025). The credibility of regulatory safety assurances depends, in part, on the degree to which the underlying methodology can be independently examined. Where such examination is precluded, those assurances cannot be scrutinised.

Finally, the post-approval monitoring system - which is intended to ensure that emerging evidence of risk is identified and acted upon after products reach the market - is reliant on market authorisation holders (MAHs) to self-report relevant new scientific data as part of their annual Benefit-Risk Submission Reports (BRSRs), signal notifications and previously via Periodic Safety Update Reports (PSURs). This system is designed to provide systematic, periodic evaluation of the accumulated evidence on product safety and to reassure regulators that the benefit–risk balance remains favourable. This creates an obvious structural weakness: the adequacy of ongoing safety surveillance depends on the completeness of industry reporting, with no independent mechanism to ensure that all pertinent research is captured and considered. A Freedom of Information Request reveals that no published scientific literature on emerging risks of companion animal parasiticides has been submitted through this process by MAHs since May 2024, when searchable submission formats were introduced (VMD, 2026a) - despite studies published in this period that could reasonably be considered relevant (e.g. Berny et al., 2026). The VMD declined to provide equivalent information for the period prior to May 2024, citing resource constraints (VMD, 2026a). When resource constraints are not cited as a ground for refusal, requests for this information have been declined on the grounds of commercial sensitivity (VMD, 2026b). This raises concerns regarding the robustness and transparency of current pharmacovigilance processes.

5. What interventions would reduce the environmental and

human health risks of the pet parasite medications?

We highlight five potential interventions – these should be considered as a suite of complementary activities which could take place in parallel or in any order depending on the speed of change in different areas:

i) Subscription schemes: currently around a third of UK pets are signed up to one of many monthly subscription schemes that typically offer discounts on veterinary services and supplies, but almost all of which provide year-round parasiticide medication without prior testing or risk assessment. This so-called 'blanket treatment' is against both BVA (British Veterinary Association), BSAVA (British Small Animal Veterinary Association) and BVZS (British Veterinary Zoological Society) policy and is contrary to the guidelines for the Practice Standards Scheme from the RCVS (Royal College of Veterinary Surgeons). Whilst veterinary businesses may claim that parasiticides are provided on the base of a risk assessment and the prescribing veterinarian's clinical judgement, in practice these subscription schemes place pressure on veterinarians to prescribe blanket parasite treatments, as pet owners, understandably, want their money's worth. The inclusion of veterinary medicines in subscription schemes inherently promotes overuse – removing parasiticides from these subscription schemes would likely dramatically reduce this blanket treatment.

ii) Prophylactic use: despite the policies and guidelines referred to above, the veterinary and pharmaceutical industries currently adopt a highly risk averse approach to parasite treatment, widely adopting proactive prophylactic use of parasiticides, despite an absence of robust epidemiological evidence on pet-parasite related disease incidence to support this approach. A shift to reactive treatment, as is the norm in many other countries such as Denmark, would be both rational and evidence-based and would reduce unnecessary usage. A shift towards more targeted, reactive flea treatment is supported by strong evidence showing rapid efficacy of new isoxazoline ectoaprasiticides at resolving household flea infestations without the need for household insecticide sprays – undermining the rationale for routine flea prophylaxis (as described in point 3).

iii) Legal category: many of the parasiticides of concern are currently available without the need for prescription, raising the possibility both of overuse and failure to understand or follow treatment guidelines. Many formulations of Fipronil are available over the counter with no restriction at all (AVM-GSL). Some of the formulations containing Imidacloprid are categorised NFA-VPS requiring advice from a vet, pharmacist or other Suitably Qualified Person (SQP) before supply, although anecdotal evidence suggests that these restrictions are not always fully complied with, and the potential for environmental harm is often not raised as an issue.

All formulations containing fluralaner are currently on prescription only (POM-V), but some other parasiticides of this isoxazoline type are now categorised as NFA-VPS.

Given the environmental and health concerns outlined above, there is a clear argument for raising all pet parasiticides to POM-V status so that they would only be used in cases of infestation or confirmed high risk, in line with the way that antibiotics are used. But as a minimum, raising the legal categories of all AVM-GSL parasiticides to NFA-VPS and ensuring that all Suitably Qualified Persons are better informed of the potential for human and environmental health risks would help to reduce the current scale of use.

iv) Labelling and package inserts: as currently published, many of these inserts do not state that treatment should be reserved for diagnosed or high-risk cases, and some give advice on, for example, swimming and bathing that disregards the published data on environmental contamination after topical parasiticide medication. One market-leading product states "The veterinary medicinal product should not enter water courses as imidacloprid and moxidectin may be dangerous for fish and other aquatic organisms. Dogs should not be allowed to swim in surface waters for 4 days after treatment". It is, however, now known (from VMD-funded research) that these chemicals may still wash off fur in significant quantities for up to 28 days after application, so animals treated topically each month can be a year-round source of environmental contamination. Manufacturers should be obliged to give advice that accurately reflects the current state of knowledge.

v) The establishment of a rigorously independent scientific advisory body to provide guidance to veterinary professionals on the responsible use of pet parasiticides, supported by robust conflict-of-interest management policies governing best-practice guideline development, would represent a significant step forward. Currently, guidance is primarily provided by the European Scientific Council Companion Animal Parasites (ESCCAP) and, to a lesser extent, RUMA CA&E - both of which maintain strong financial ties to the veterinary pharmaceutical industry. In human medicine, best-practice guidelines are expected to be developed by multidisciplinary, transparent panels with explicit conflict-of-interest management, grounded in systematic reviews or the best available evidence, and incorporating clear methods for weighing evidence quality, benefits, risks, and values (Guyatt et al., 2008; Schünemann et al., 2015). ESCCAP guidelines (ESCCAP, 2024) do not comprehensively incorporate these standards: they frequently promote routine prophylactic parasiticide use, cite no primary evidence, offer little explicit consideration of both the human and environmental risks arising from parasiticide use, and lack transparent, rigorous conflict-of-interest management processes.

6. What are the key knowledge gaps that need to be addressed to improve the environmental risk assessment for pet parasite medication?

The existing environmental risk assessment (ERA) framework for pet parasiticides rests on the foundational assumption that medicines used in pets result in negligible environmental exposure. Under the two-phase VICH GL6/GL38 framework, products intended for use in non-food-producing animals such as cats and dogs have, since the late 1990s, been permitted to conclude their ERA at Phase I - without requiring any data on environmental fate, behaviour, or ecotoxicological effects (EMA, 2000). The reasoning was straightforward: pets are not intensively reared, so individual treatment volumes were considered too low to pose a meaningful environmental risk.

The validity of this assumption is increasingly being questioned. With companion animal populations growing across the EU/EEA, product use intensifying, and widespread environmental contamination from pet parasiticides now demonstrated, the EMA has acknowledged that the assumption of negligible environmental exposure may no longer be justified (EMA, 2023) - meaning products may have been authorised for decades on a scientifically invalid assumption.

The immediate practical consequence of the historical assumption of negligible environmental exposure is significant: there is currently no harmonised, product-based environmental risk assessment methodology applicable to parasiticides used in cats and dogs. The European Medicines Agency (EMA) is now working to address this through a new guideline on ERA methodology, adopted for public consultation in June 2025 (EMA, 2025). However, as the concept paper makes clear, the aim is to define data requirements for applicants for submission in the frame of a marketing authorisation application - meaning the guideline is prospective in scope and will apply to new products only, not to medicines already on the market. Existing authorisations are not subject to an automatic retrospective ERA requirement, though regulatory mechanisms under Regulation (EU) 2019/6, including referral procedures and post-authorisation variations, could in principle be used to require updated environmental data where new evidence of harm emerges.

A central challenge in developing new guidelines on environmental risk assessments is that the pathways through which companion animal parasiticides reach the wider environment are multiple and complex. The proposed guideline will need to address routes of entry into the environment with a focus on down-the-drain pathways and direct soil and water contamination, and develop exposure modelling for the relevant routes. These include direct routes such as dogs swimming or bathing in surface water and faecal and urinary excretion outdoors, as well as indirect routes such as wash-off from treated animals and contaminated bedding entering the sewage system. None of these pathways are currently factored into regulatory assessments, and suitable exposure scenarios must be developed from the ground up before a Phase II ERA can be meaningfully conducted.

Compounding this is a lack of underlying toxicological and environmental fate data, particularly for newer active substance classes. The forthcoming guideline will define the environmental fate and effects data to be provided - including published data and scientific publications - that will allow for an ERA to be conducted. Until that framework is established, the science needed to properly evaluate risk simply does not exist in a form regulators can apply consistently.

Even where concerns have been identified, no agreed framework for managing them exists. The proposed guideline will include discussion of appropriate risk mitigation measures, confirming that appropriate management of identified environmental risks remains a knowledge gap.

7. What is the economic value of pet parasite medication to the veterinary pharmaceuticals industry?

Detailed and accurate figures are deemed commercially sensitive and therefore not freely available in the public domain. However, published estimates allow for a broad assessment of market scale. Estimates of the total UK animal medicines market vary widely, ranging from £713 million per year (NOAH website) to £2.1 billion per year (Grand View Research, 2024). Similarly, estimates of the pet parasiticide market alone range from £380 million per year - for flea, tick and heartworm treatments (Grand View Research, 2025) - to over £790 million per year, a figure derived from assumptions embedded in a recent industry-funded modelling paper (see below).

The scale of this market is further highlighted by a recent paper by Giannelli et al., (2025), which modelled the animal health and economic benefits of routine parasiticide use under full compliance with industry-affiliated ESCCAP (European Scientific Counsel Companion Animal Parasites) guidelines. The paper estimated that if ESCCAP guidance were fully followed, treatment rates - and, under the paper's assumptions, the corresponding proportion of avoided infestations - would increase by 70.6%, indicating substantial scope for market growth beyond current levels. The authors also estimated that current prevention practices save UK households approximately £53 million per year in avoided veterinary costs.

However, this paper has attracted criticism, including from members of the PREPP team, with critics noting that the estimated savings to pet owners are not contextualised against the costs of routine parasiticide use itself - costs which, on reasonable assumptions, appear to far exceed the projected savings (Loeb, 2026). Using Giannelli et al.'s own assumptions alongside a provisional estimate of £6 per month for ectoparasite treatment, annual UK spending on flea treatment alone would exceed £790 million. This would suggest that the estimated cost of flea treatment (£790m) is considerably more than the avoided veterinary costs (£53m). Such a comparison is important in assessing the relative cost-benefit to the public of routine parasiticide use.

Taken together, these figures underscore the substantial and growing economic importance of the pet parasiticide sector to the veterinary pharmaceuticals industry, while also highlighting the limitations of industry-funded modelling in assessing net value to consumers.

What proportion of medications being prescribed or sold contain fipronil, imidacloprid or other pesticides of concern?

Data from 2024 across all the sales channels (vets, pet shops, online sales, supermarkets) is not currently available, but of the products **sold through veterinary clinics** in 2024 (Kynetek, 2025), the breakdown of the top 3 **topically applied** products by number of doses is:

- Imidacloprid 53%
- Fipronil 29%
- Fluralaner 5.7%

The proportion of total sales of all formulations across all channels in 2017 (Kynetek, 2025) were:

Imidacloprid 48%

Fipronil 21%

Fluralaner 17%

8. **What is the current advice being given to pet owners in relation to pet parasite medication? Should the advice to pet owners be changed?**

A survey of pet owners by Perkins & Goulson (2023) found that veterinary advice on pet ectoparasite treatment is dominated by a blanket prophylactic approach. The large majority of pet owners surveyed (81.3%) reported being advised by their veterinarian to apply flea and tick treatments year-round, regardless of individual risk. Only 7.6% received risk-stratified advice - such as treating only during warmer months or in response to active infestation - while 11% received no advice at all. These findings suggest that current veterinary guidance overwhelmingly favours routine, continuous treatment over targeted, evidence-based application.

This advice warrants revision. Routine year-round treatment without individual risk assessment is inconsistent with responsible medicine use and increases the environmental load of parasiticides unnecessarily. A risk-stratified approach or reactive approach - guided by factors such as the animal's lifestyle and seasonal exposure - would reduce unnecessary chemical use while maintaining acceptable parasite control, in line with One Health principles (considering the interconnection between human, animal and environmental health).

9. **What is the current advice being given to veterinarians on the correct usage of pet parasite medication?**

Guidance to the veterinary profession on responsible parasiticide use is currently inconsistent and contradictory. Whilst there is broad consensus that parasite control should be risk-based and responsible, significant disagreement exists about what this means in practice and how competing risks - to animal health, human health, and the environment - should be weighed.

The most prominent source of prescribing guidance is ESCCAP, whose representatives have advocated routine, year-round endo- and ectoparasiticide treatment for UK cats and dogs (Wright, 2020; 2022; 2023). It has been estimated that full compliance with ESCCAP guidelines would result in a 70% increase in UK pet parasiticide use over current levels (Giannelli et al., 2025).

The BVA, BSAVA, and BVZS take a more cautious position, recommending that veterinary professionals avoid blanket treatment and instead risk-assess each individual animal, taking into account animal, human, and environmental health considerations (BVA, BSVA and BVZS, 2025). These associations have jointly issued a five-point plan outlining the principles of responsible parasite control (BVA, 2022), and have published policy position statements calling for a more considered approach and highlighting existing knowledge gaps. However, these policy positions do not extend beyond broad principles and offer little practical clinical guidance.

The RCVS Practice Standards Scheme reinforces this position at a regulatory level. Its core accreditation criteria state that practices must demonstrate responsible use of endo- and ectoparasiticides, considering the specific needs of each animal - including lifestyle factors and owner or household vulnerabilities - before prescribing POM-V and POM-VPS products, and that a blanket approach must not be taken (RCVS, 2024).

The veterinary sustainability organisation Vet Sustain has gone further in providing practical resources to support responsible prescribing, including individual animal risk assessment tools and a detailed FAQ document covering the evidence base for responsible pet parasiticide use, resistance concerns, and the broader risks associated with current prescribing practices (Vet Sustain, 2025).

A central and unresolved challenge is the absence of any agreed definition of what constitutes risk-based parasite control. This is well illustrated by divergent guidance on seasonality in flea treatment. The evidence clearly shows that season is a risk factor in the UK: flea infestations can occur year-round but are significantly more prevalent in summer and autumn than in winter and spring (Farrell et al., 2023). ESCCAP parasitologists have interpreted this to mean that year-round prevention is warranted, on the basis that some risk is present at all times (Wright, 2026). Vet Sustain, by contrast, interprets the same evidence as supporting targeted treatment during higher-risk periods (Vet Sustain, 2025). This disagreement over the application of risk-based principles exemplifies the broader inconsistencies in current guidance.

Should the prescription status of these medications be changed?

See above in response to question #5 (point iii)

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