Water Hazard 2.0

Continued Aquatic Contamination from Neonicotinoid Insecticides

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Background

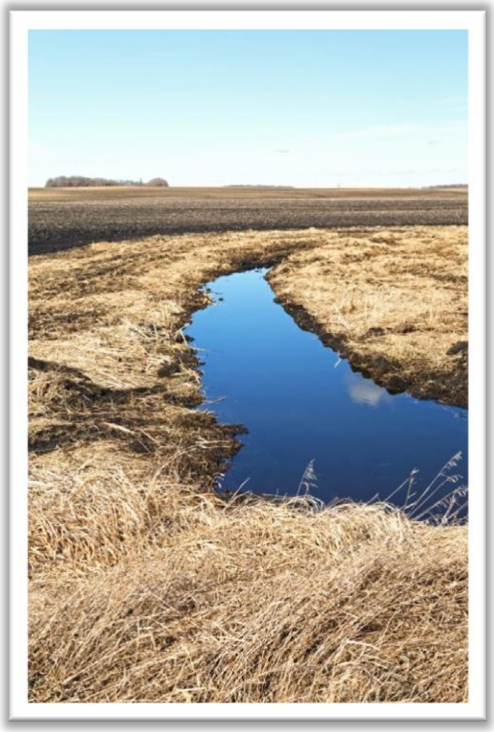
Since the early 2000s, research linking the use of neonicotinoids and other systemic insecticides with severe pollinator declines has continued to build.[1] The most recent U.S. Department of Agriculture (USDA) supported survey documented a 44% reduction of managed honey bees in 2015 and a study performed by United States Geological Survey (USGS) researchers found several pesticides known to cause harm to pollinators in a majority of wild bee samples in agricultural fields.[2] While impacts to pollinator species remain a priority concern, emerging research now also exposes neonicotinoids as a leading environmental contaminant, poisoning landscapes across the country; most notably our aquatic ecosystems.

Resilient and diverse aquatic ecosystems are essential to environmental stability. Within the last decade the use of highly toxic and persistent neonicotinoids has become a hazard to the waters that both people and wildlife such as fish, amphibians, and birds rely on. Introduced in the 1990s, neonicotinoids[i] are water soluble and systemic in nature, meaning they are taken up in the vascular system of a treated plant, thereby rendering the whole plant toxic.[3] This systemic quality allows for numerous types of applications, including foliar, trunk injections, soil drenches, and seed coatings—a prophylactic approach to pest management that has failed to reliably produce higher crop yields and has caused an array of environmental contamination concerns (see 2016 *Net Loss* report).[4]

Despite severe risks of unintended contamination, these neonicotinoid coated-seeds are applied annually on approximately 150 million acres, or about one-fourteenth of the land area of the contiguous United States.[5] The runoff from their use then flows—both above and below ground—far beyond the agricultural fields, gardens, trees, lawns, and many other areas where they were first applied, causing inadvertent insecticidal effects on non-target species across a vast measure of additional wetlands and water bodies. The 2015 Center for Food Safety report, *Water Hazard: Aquatic Contamination by Neonicotinoid Insecticides in the United States* analyzes the high levels of neonicotinoid water contamination documented across the country, often at levels that exceed vital standards set to protect aquatic life.

[i] Imidacloprid, Clothianidin, Thiamethoxam, Dinotefuran, Acetamiprid

In the time since the *Water Hazard* report was released, the U.S. Environmental Protection Agency (EPA) has taken steps to acknowledge the levels of contamination from these chemicals and has developed more conservative benchmarks for aquatic life. However the agency has yet to take any concrete actions to implement stronger regulations, restrict neonicotinoid uses, or enforce more comprehensive water quality monitoring. Rather, the EPA once again has unilaterally extended its own timeline for completing the final neonicotinoid Registration Reviews—this time until the winter of 2018/2019. This delay is problematic in that EPA may potentially wait for all registration review documents to be finalized before taking any strong action to protect pollinators and aquatic ecosystems from this systemic class of insecticides. Based on the wealth of independent, peer reviewed research highlighting the dangers of neonicotinoids, the EPA's delay and failure to act is a threat to our aquatic ecosystems and by extension our water supply and the country's long term environmental health and economic prosperity.



This supplemental report explores new data on water contamination, along with key findings about the unique damage caused by neonicotinoids. It concludes with updates from detailed Canadian monitoring studies and consequent Canadian agency analysis and regulatory actions, an overview of EPA's aquatic risk assessment for imidacloprid, and policy recommendations for EPA moving forward.

Contamination Continues

A 2016 USGS review of pesticide detections in streams across the Midwest found high concentrations of imidacloprid—the most widely used neonicotinoid—in 98% of the sites sampled.[6] The report reveals imidacloprid levels at the highest concentrations of all the insecticides tested; 2.86 ppb, a concentration that far exceeds levels known to cause harm to aquatic invertebrates.[7] The USGS review is part of a growing body of research that highlights the alarming levels of contamination exposed in national and regional monitoring data,[8] and builds on other reported detection frequencies such as: the 76% detection rate of one or more neonicotinoids in streams across the Midwest in 2013,[9] the 70% detection frequency of downstream samples in the southern Appalachians in 2012 and 2013,[10] and an overall 63% detection rate in streams sampled across the United States.[11] Of more concern, these data likely underestimate the overall contamination rates of the entire neonicotinoid class, as will be explained in more detail.

A 15-year analysis by USGS presented in the EPA's *Preliminary Aquatic Risk Assessment to Support the Registration Review of Imidacloprid*, shows that imidacloprid use increased from nearly ¼ million pounds around the year 2000 to more than 2 million pounds in 2014. Yet during this time, monitoring data for the chemical, with one exception, decreased significantly.[12] Despite these limitations, researchers still found an average imidacloprid detection rate of 36.5% across all surface water bodies tested during these years.[13] Clothianidin and thiamethoxam are not included in this analysis, but they are the primary insecticides used on commodity crops such as corn and soy via seed-coating application in the United States.[14] If the data encompassed all neonicotinoid insecticides and was regularly monitored by scale of use, the detection frequencies would likely be even higher.

Neonicotinoids in our tap water?

A 2017 study from USGS and the University of Iowa, *Occurrence of Neonicotinoid Insecticides in Finished Drink Water and Fate During Drinking Water Treatment*, found imidacloprid, clothianindin, and thiamethoxam in 100% of samples taken from University of Iowa tap water. The concentrations detected range from 0.00024 ppb to 0.0573 ppb. The report is the first peer reviewed study to examine neonicotinoid concentrations in finished drinking water and explores the particular threat posed to communities that rely on surface water impacted by agriculture. Although the study is limited to a small sampling area, the authors of the report conclude, "because of their pervasiveness in source waters, and persistence through treatment systems, neonicotinoids are likely present in other drinking water systems across the United States." This study is preliminary and did not expose any concentrations known to have direct impact on humans, however the 2015 National Institute of Health review paper, *Effects of Neonicotinoid Pesticide Exposure on Human Health: A Systematic Review*, called for further research on the chronic impacts of these ubiquitous chemicals. Currently the EPA has no standards for neonicotinoids in drinking water.

A 2017 study from Purdue University, *Effects of clothianidn on aquatic communities: Evaluating the impacts of lethal and sublethal exposure to neonicotinoids* by Miles et al. exposes the skew in neonicotinoid data that focuses only on imidacloprid use by highlighting data from field and mesocosm studies to examine the impacts and frequency of clothianindin and thiamethoxam—the two primary insecticides used in U.S. cropping systems.[15] In an Indiana field study, the authors of the report detected clothianidin in 81% of soil samples at a mean concentration of 24.2 ppb and a maximum concentration of 176 ppb. Clothianidin was then found in 96% of water samples at a mean concentration of .10 ppb across all sites and at a maximum concentration of .67 ppb. The authors also detected thiamethoxam in 98% of water samples at an average concentration of 302 ppb and a maximum concentration of 2568 ppb. To put these numbers into context, the acute aquatic life benchmark established by EPA for freshwater invertebrates is 17.5 ppb for thiamethoxam and 11 ppb for clothianidin. The maximum concentration found in the Miles et al. study for thiamethoxam was roughly 146 times higher than the benchmark established by EPA and even the average concentration for thiamethoxam was 17 times higher than the acute threshold.[ii] By conducting field realistic analysis of impacts to ecosystem services the authors of the report conclude,

[ii] The EPA has yet to complete the registration review process for thiamethoxam and clothianidin. The aquatic life benchmarks established are likely overestimates of the thresholds necessary to protect aquatic life.

"Our results demonstrate that the neonicotinoid clothianidin can have lethal and sublethal effects on aquatic invertebrates. While more work examining other neonicotinoids is necessary to assess generality, our work combined with existing studies suggest that the most widely used compounds in this insecticide class have the potential to significantly alter aquatic communities, highlighting the need for more research into the community -and ecosystem- level consequences of exposure."[16]

In order to fully quantify the risk posed by the continued use of these systemic insecticides, it is critical that monitoring data as well as research take a holistic approach and consider the impact of all neonicotinoid insecticides—not only imidacloprid. This is also true in assessing possible mitigation strategies.

Methods to mitigate the transport of these persistent and water-soluble chemicals from the field into nearby aquatic ecosystems or pollinator forage areas are not reliable. A 2017 USGS study, *Neonicotinoid insecticide removal by prairie strips in row-cropped watersheds with historical seed coating use*, by Hladik et al. measures neonicotinoid residues in different sources near corn and soybean fields with history of neonicotinoid seed coating use.[17] The report investigates the efficacy of prairie strips in reducing neonicotinoid contamination. After sampling areas adjacent to fields planted 2-3 years prior, the researchers found clothianidin in 100% of the control sites (no prairie strips used) for groundwater, surface water, and soil. From similar samples taken from areas where prairie strips were used, clothianindin was found at rates of 89%, 50%, and 33% respectively. Although this data shows that prairie strips may reduce contamination in non-target areas, it does not adequately mitigate the risk. Surface water and ground water samples from sites with prairie strips showed clothinindin at concentrations up to 1.2 ppb and .2 ppb respectively—surpassing the acute thresholds established in a 2015 peer reviewed analysis of available neonicotinoid data and research.[18]

Damages to Ecosystem Functioning

With the increase in research confirming widespread contamination of surface and ground water from neonicotinoid insecticides it is critical to examine impacts on aquatic invertebrates as well as broader repercussions for watershed ecosystems. The 2015 *Water Hazard* report explores not only neonicotinoid detection frequencies, but also more specifically the high risk posed by the concentration levels detected. Further, it examines the implications of the lax EPA aquatic life benchmarks that were at the time some of the least conservative thresholds in the world.

In the 2017 *Preliminary Aquatic Risk Assessment to Support the Registration Review of Imidacloprid,* EPA updated these benchmarks and acknowledged the threat of imidacloprid to aquatic communities.[19] The assessment found that a startling 94% of the agricultural use scenarios modeled identified acute risk to freshwater invertebrates. The agency report concludes, "It is evident ...that concentrations of imidacloprid detected in streams, rivers, lakes and drainage canals routinely exceed acute and chronic toxicity endpoints derived for freshwater invertebrates."[20]

Also in the assessment, the EPA proposed new benchmarks based on both acute and chronic lab testing as well as field realistic studies. The proposed thresholds are 0.39 ppb for acute exposure and 0.01 ppb for chronic exposure. These figures are in line with the standards set by Canada's Pest Management Regulatory Agency and the European Union's European Food Safety Authority. However, EPA is doing nothing to enforce these proposed safety standards in the United States, rendering the benchmarks essentially meaningless.

A 2016 review paper, *Contamination of the Aquatic Environment with Neonicotinoid and its Implication for Ecosystems* by Sanchez-Bayo et al., exposes the dangers of the high levels of neonicotinoids reported in waterways around the world. The authors synthesize key research on ecosystem services, species sensitivity, and long-term mesocosm studies.[21]

Although Sanchez-Bayo et al. evaluate several application methods and consider the unique toxicity of this class of systemic insecticides, the authors emphasize that a majority of soil and water contamination is a result of the extensive use of the neonicotinoids as seed coatings specifically. While much of the research focuses on the sub-lethal impacts of neonicotinoids to aquatic species, the authors extrapolate the larger repercussions of these changes to the ecosystem, and warn against continuing neonicotinoids' prophylactic use in agriculture.

The increasing detection frequencies and concentrations are an indication of the even higher residues likely to be found in soil sampling, as most neonicotinoid insecticides are applied to seeds directly and 80-90% of the insecticide on the coated seed remains in the soil after planting.[22] Sanchez-Bayo et al. explain that due to slower dissipation rates in soil than in water it is probable that, *"the increasing use of products containing neonicotinoids and their repeated application as coated seeds in agricultural fields adds every year a new layer of residues to the soil and hence to the waters, where residue levels are a reflection of those present in soil at any time."*[23]

In certain climactic conditions and soil types, imidacloprid can have a half-life of up to 229 days in soils.[24] This soil contamination impacts beneficial organisms such as earthworms, which are critical to soil health and continued land use. A 2015 study by Wang et al. shows a LC_{50} of 3050 ppb of imidacloprid and that a sub-lethal dose of 2000 ppb, caused an 84% decrease in fecundity of earthworm species.[25]

Based on their comprehensive review of available neonicotinoid research, Sanchez-Bayo et al. alarmingly conclude, "Negative impacts of neonicotinoids in aquatic environments are a reality" and continue, "Solutions must be found soon if we are to save the biodiversity not only of aquatic ecosystems, but all other ecosystems linked by the food web."

Unique Threats to Species Adversely Impacted

While neonicotinoids are proven to be toxic to a vast array of species at fairly low doses, new long term research in field-realistic scenarios shows that neonicotinoids pose unique threats to species impacted, most of which are hard to quantify using toxicity benchmarks. Perhaps the greatest threat is the chemical class' distinctive mode of action that results in extreme variation of median toxicity values based on exposure time. Neonicotinoids kill invertebrates by binding irreversibly to receptors within the nervous system.[26] At high doses this can be instantly lethal. At low doses, the continued binding from this chemical eventually leads to damage of individual neurons.[27] Continued exposure at low doses leads to a growing number of damaged neurons. During the period of neural damage, individuals experience confusion, weakened immune systems, and changes in body size, emergence timing, and feeding habits.[28] Eventually, after prolonged exposure, the animal's nervous system can no longer survive the damage, leading to paralysis and ultimately death. This is a gateway to larger harms to the species' overall survival rates as well as to ecosystem health. What sets neonicotinoids apart from other inhibitors such as pyrethroids and organophosphates is that the neurons destroyed by exposure do not

regenerate over time.[29] This underscores the urgent need for strong action on neonicotinoid regulation to avoid continued irreparable damage to species impacted.

Furthermore, in an aquatic environment, repeated low dose exposures are particularly concerning, given that species in these contaminated aquatic ecosystems typically cannot escape exposure in the same ways terrestrial invertebrates may be able to by moving to less contaminated areas. Rather than immediate death from direct exposure, large numbers of species die after several weeks of exposure—as demonstrated in an increasing number of long term mesocosm studies conducted in the past several years.[30]

Based on the unique threat to aquatic ecosystems as well as neonicotinoids' systemic nature, propensity for accumulating in the environment, and ability to cause sub-lethal impacts at low doses, Sanchez-Bayo et al. argue, "protective levels for neonicotinoids cannot be achieved by setting a concentration benchmark because…the effects of neonicotinoids increase with exposure time."[31] These findings specifically alert us to the need for regulatory action to restrict uses of neonicotinoids and highlight the weaknesses of possible mitigation strategies.

Rippling Effects throughout the Food Web

Data showing direct risk to aquatic species such as fish or amphibians are limited but growing.[32] However, the widespread contamination exhibited by previous monitoring studies show concentration rates known to be harmful to aquatic invertebrates—the foundations of aquatic ecosystems. Even at notably low doses, neonicotinoids alter population ratios and predator-prey relationships, causing rippling effects throughout the entire food web. This harms vital ecosystem functions.

For example, chronic impacts to species may include feeding inhibition. Some of the species shown to be most sensitive to neonicotinoid contamination include mayflies, caddisflies, and stoneflies, all of which aid in the decomposition of organic matter in water bodies.[33] Through shredding of leaves and debris found in creek and stream floors, these species not only feed themselves and maintain healthy population levels, but they also safeguard water quality standards for other organisms.[34] When exposed to low doses of neonicotinoids over time, the decomposers do not carry out vital ecosystem services and are also unfit to reproduce, further exacerbating the problem through population decline.[35] According to Sanchez-Bayo et al. 2016,

> *"Given that more than half of the waters are contaminated with neonicotinoid levels that impair this important ecosystem function, higher organic and inorganic pollution can be expected wherever these insecticides are present. Microbial degradation of the debris may still occur, but it would be slower and produce undesirable byproducts such as methane and sulfides."*[36]

This is but one of the ecosystem services jeopardized by continued use of neonicotinoid insecticides that must be considered in comprehensive cost-benefit analyses.

Perhaps aquatic insects seem like an underwhelming target for conservation efforts, but in reality they play a critical role in the healthy functioning of the ecosystem. They are the primary food source for fish, amphibians, and other aquatic wildlife. The significant threat to insect populations from neonicotinoids can lead to the depletion of insectivorous fish through starvation. Although neonicotinoids are not typically found in concentrations proven to be lethal to most fish species,[37] the documented decline of insect species fish rely upon will likely have an impact on their health and survival.[38] Similar effects are foreseeable for aquatic birds.[39]

Confirmation of Toxicity and Subsequent Regulatory Actions from Canada

In 2016, in response to the weight of evidence showing detrimental impacts from neonicotinoid insecticides to aquatic ecosystems, Canada's Pest Management Regulatory Agency (PMRA) released a re-evaluation of imidacloprid. The review includes a wealth of data from both government and peer-reviewed research and concludes (emphasis added):

> *"The environmental assessment showed that, in aquatic environments in Canada,* ***imidacloprid is being measured at levels that are harmful to aquatic insects****. These insects are an important part of the ecosystem, including as a food source for fish, birds and other animals. Based on currently available information,* ***the continued high volume use of imidacloprid in agricultural areas is not sustainable."***[40]

Noting the continued exceedance of water quality thresholds and aquatic life benchmarks in monitoring data, PMRA proposed action necessary to protect aquatic ecosystems from imidacloprid and called for similar evaluations for other neonicotinoid insecticides. Specifically, PMRA proposed to *"phase-out all the agricultural and a majority of other outdoor uses of imidacloprid over three to five years."*[41]

While this proposal received initial industry pushback,[iii] in a webinar to discuss the imidacloprid reevaluation and proposed phase out PMRA defended the need for strong regulation noting the chemical's water solubility, persistence, and capacity for unintended contamination of vital waterbodies. PMRA officials stated that based on the research provided by the reevaluation, a phase out of the chemical was the best option for risk mitigation. Further within the phase out proposal, PMRA reasoned against any alternative use reduction plans stating (emphasis added):

> *"Given the risks that have been identified and considering the available information, effective risk mitigation through a use-reduction strategy would be difficult to achieve for several reasons. It would be difficult to identify the specific uses that are causing the elevated levels in water given that much of the water monitoring data were from mixed-use areas of agriculture. In addition,* ***it is not possible to accurately predict how much use reduction would be necessary to achieve acceptable levels of imidacloprid in the environment*** *and, therefore, any use-reduction strategy would require extensive and comprehensive water monitoring information to confirm that risk reduction targets are being achieved.* ***It is also not possible to estimate how long a reduction in environmental levels would take****. In addition, in sectors where imidacloprid is approved for use but not currently used extensively, intensification of use in the future may lead to additional risks of concern. Given the above, phase-out of all outdoor agricultural, ornamental, turf, and tree uses (except tree injection uses) and greenhouse uses of imidacloprid is being proposed."*[42]

PMRA's analysis and subsequent planned action is consistent with the 2016 study conducted by Struger et al. This three-year investigation of contamination in surface water sites across southern Ontario reveals three of the five neonicotinoids tested (imidacloprid, clothianidin, thiamethoxam), had more than 90% detection rates in more than half of the sites.[43] The Canadian government's threshold for imidacloprid residues in freshwater is 0.23 ppb, which was exceeded in 75% of the samples collected in two sites. The data shows strong correlations between pesticide detection, precipitation, and stream discharge.[44] Other Canadian monitoring data by government and independent researchers reveals 98.7% detection frequency of thiamethoxam and 100% detection frequency of clothianidin in Southwestern Ontario water samples from corn-producing counties,[45] and 91% neonicotinoid detection (imidacloprid, thiamethoxam, clothianidin, acetamiprid) in wetlands sampled across the Prairie Pothole region.[46] Across

[iii] Additional industry pushback was received during the Canadian Parliament's Standing Committee on Agriculture and Agri-Food meeting on the PMRA Decision Concerning the Neonicotinoid Insecticide Imidacloprid. During the hearing industry expressed concerns about resistance issues if farmers no longer had access to imidacloprid and instead had to use other pesticides. CFS strongly disagrees with these concerns about resistance based on the preexisting documented instances of imidacloprid resistance. Furthermore the industry should not be focused on what chemicals to replace imidacloprid with but rather should invest in alternative pest management practices that already exist and are more sustainable.

all studies, researchers note the long-term persistence of neonicotinoids and highlighted risks to wetlands in colder climates where the chemicals persist in soil and are transported in the spring via snowmelt to nearby surface water.[47]

A 2017 report from Chretien et al. of Agriculture and Agri-Food Canada and Quebec Ministry of Sustainable Development, also raises concerns about contamination from surface runoff and subsurface tile drain losses, with a particular focus on the contamination by clothianidin and thiamethoxam. The report documents a two-year study in which 14 surface runoff and tile drain discharge events were monitored. The researchers report, "detection frequencies close to 100% in edge-of-field, surface runoff and tile drain water samples…for thiamethoxam and clothianidin even though only thiamethoxam had been applied in the first year."[48] These findings highlight the persistent nature of these agrichemicals in certain climates and soil conditions as well as the potential harm of their degradants. The insecticides were reported at median concentrations of 0.46 ppb and 0.16 ppb; many exceeded the 0.0083 ppb chronic threshold for effect on aquatic life recommended by Government of Quebec.[49] The authors concluded by echoing the proposal in the Quebec Pesticide Strategy 2015-2018 and explained why conceivable plans for reduced use or other mitigation strategies to control dust and surface runoff would be insufficient.

The data collected by Chretien et al. is more alarming given that there are currently no ecological thresholds established for thiamethoxam or clothianidin in Canada.[50] This major shortcoming is particularly an issue in Quebec where nearly 100% of corn and 50% of soybean seeds are planted with neonicotinoid seed coating—covering more than 1.2 million acres.[51] Giroux et al. found detection frequencies of thiamethoxam and clothianidin ranging from 93% to 98% from 2012 to 2014 in four Quebec watersheds.[52] Canada's increasing documentation of neonicotinoid contamination supports PMRA's analysis and their proposal for stronger regulatory protections for the environment through a phase-out of agricultural and outdoor uses of imidacloprid and potentially additional neonicotinoids in the future.

EPA's Aquatic Risk Assessment: Strong Science, No Action

Shortly following the release of the PMRA analysis in early 2017, EPA's Office of Chemical Safety and Pollution Prevention released the *Preliminary Aquatic Risk Assessment to Support the Registration Review of Imidacloprid* as part of the agency's ongoing registration review of neonicotinoid insecticides. The agency's evaluation includes detailed outlines of the assessment procedures and qualitative risk analysis. EPA's findings incorporate data from PMRA as well as the European Food Safety Authority and reach similar conclusions on the aquatic risks—yet these findings have resulted in no further EPA regulations or restrictions to parallel the actions of Canada and Europe.

This report update is a continuation of the research first underscored in *Water Hazard* and emphasizes the immediate need to reverse EPA's failures and promptly reduce the widespread neonicotinoid contamination of America's waters. The following analysis of the shortcomings of EPA's *Preliminary Aquatic Risk Assessment to Support the Registration Review of Imidacloprid* includes recommendations for EPA to implement in order to safeguard aquatic ecosystems, our water supply, and the country's long term environmental health and economic prosperity.

Notable Shortcomings of EPA's *Preliminary Aquatic Risk Assessment to Support the Registration Review of Imidacloprid*

1. **Gross Underestimation of Seed Treatment Contamination and Risk**

   The EPA analysis proposes the unrealistic assumption that neonicotinoid chemicals applied as treatments on seeds planted below two centimeters do not move into surface waters and therefore are low risk.[53] It is unacceptable that EPA's models do not account for lateral movement of these chemicals in soil and run-off. It is well-known that these chemicals move down into the ground water—to assume they don't move laterally through surface soil (especially surface soil broken up by tillage) with precipitation is indefensible in view of numerous published reports showing that they do so.[54]

   Roughly 1,116,000 pounds of imidacloprid were used on crops in the United States between 2004 and 2013. Fifty-six percent of this usage was as seed coatings—and more specifically 36% was as a coating on soybeans.[55] The risk assessment identified acute risks to listed freshwater invertebrate species with 29 of the 31 agricultural use scenarios modeled (~94%)—of which a majority are seed coating uses.

The following graphic from the EPA risk assessment depicts the surface water contamination across the United States in relation to thresholds established for specific freshwater invertebrate species.[56] As shown, concentration levels of imidacloprid detected in various surface water bodies are routinely exceeding benchmarks known to cause harm to critical aquatic species—with certain storm event modeling showing nearly 100% exceedance.

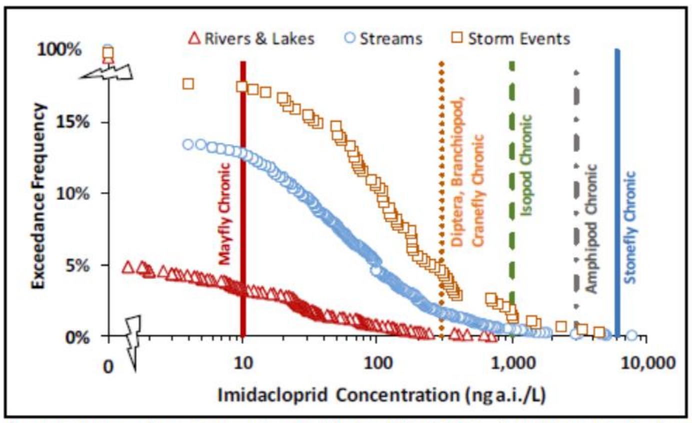


Figure 5-8. Exceedance Frequency of Imidacloprid in USGS Surface Water Monitoring Samples Relative to Chronic Toxicity Endpoints for Freshwater Invertebrates (non-detects assumed = 0)

EPA *Preliminary Aquatic Risk Assessment to Support the Registration Review of Imidacloprid*
https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0844-1086

The chart highlights imidacloprid's considerable threat to aquatic ecosystems, however it does not accurately portray the full scope of neonicotinoid contamination—particularly via seed coating. More than 90% of corn and almost 50% of soybeans grown in the United States are coated, most often with clothianidin or thiamethoxam.[57]

The overall EPA risk analysis of imidacloprid, while relevant perhaps in discussion of toxicological effect to species impacted, does not represent the broader neonicotinoid class since other neonicotinoids vary in use and application rate. **EPA in the final ecological assessment should more accurately portray the risk posed by seed-coatings and include a thorough field realistic analysis of contamination from all uses of neonicotinoid chemicals.[iv]**

2. New Endpoints but No Mandates to Ensure High Water Quality

After analyzing aquatic toxicity research, international benchmarks, and available monitoring data, and conducting acute lab testing, EPA's Risk Assessment proposed new acute and

[iv] Imidacloprid, Clothianidin, Thiamethoxam, Dinotefuran, Acetamiprid

chronic endpoints for imidacloprid for freshwater invertebrates. Prior to the Assessment, EPA's endpoints were exponentially higher than other regulatory and non-regulatory benchmarks from around the world.[58] The new proposed endpoints of 0.39 ppb (acute) and 0.01 ppb (chronic) are not only more in line with the conclusions of PMRA but they also are more consistent with the thresholds proposed by Morrissey et al., and discussed in the 2015 *Water Hazard* Report. Yet, these endpoints have not been updated on EPA's Aquatic Life Benchmarks for Pesticide Registration website. Moreover, there is no mandate by which toxicity benchmarks are enforced. According to their website, EPA's Office of Water may use the "aquatic toxicity data to develop ambient water quality criteria that can be adopted by states and tribes to establish water quality standards under the Clean Water Act,"[59] however there are no mandates to establish such standards. Given that current monitoring data shows exceedances of the proposed thresholds across the United States in various surface water bodies, **EPA should formally update proposed water quality standards and include mandated neonicotinoid testing in their final risk assessment.**

3. **No Mention of Pesticide Synergies**

EPA's aquatic risk assessment contains almost no mention of pesticide synergies and the particular threat of chemical combinations to aquatic communities unable to escape continued exposure to multiple pesticide stressors. According to Morrissey et al. 2015, "neonicotinoids are known to be additively or synergistically toxic when they occur together or when combined with certain fungicides…"[60] These combined "tank mixes" of pesticide formulations are patented and even encouraged by agrichemical companies for their increased toxicity. In fact, a 2016 Center for Biological Diversity analysis of recently approved products from major pesticide companies found that 69% of patent applications claimed or demonstrated synergistic action.[61] Additionally, when neonicotinoids were tested together for impacts on *Daphnia magna* species, a species known to be highly ***tolerant*** to neonicotinoid toxicity, the effects included notable impacts on reproduction, growth and survival in correlation to chemical synergism.[62] Due to the tendency for aquatic ecosystems to be contaminated by several neonicotinoid chemicals from a range of application sites as well as other chemicals present in surface water bodies, **EPA's final risk assessment should include the threat from combined exposure and synergistic effects of multiple pesticides.**

4. **Limited Field Realistic Conditions and Lack of Evaluation of Sub-lethal Impacts to Ecosystem Functioning and Food Chains**

The preliminary risk assessment addresses the lack of higher tier data stating:

"Due to resource and time constraints, an independent review of the higher tier aquatic toxicity data for imidacloprid was not conducted as part of this preliminary ecological risk assessment…However, the Agency expects to revise the preliminary ecological risk assessment to reflect public comment and any additional refinements deemed necessary to support risk management decisions. Such refinements, if deemed necessary, would likely include an independent review of the mesocosm data."

Moreover, EPA in its assessment of impacts to fish and aquatic phase amphibians notes:

"While the risk of direct effects of imidacloprid to fish and amphibians is considered low, the potential exists for indirect risks to fish and aquatic-phase amphibians through reduction in their invertebrate prey base."

In view of the threats to ecosystem services and food-chain stability outlined earlier in this report update, **it is critical that EPA include higher-tier and mesocosm analysis to fully determine the risk to fish and amphibian species in the final risk assessment**.

5. Ignores Risks to Other Species

Initially intended to be a complete ecological risk assessment of imidacloprid, EPA justified its decision to only include aquatic risks, stating:

"… a substantial body of aquatic monitoring and toxicity data have been generated for imidacloprid since the Agency's last comprehensive risk assessment was conducted. In contrast, very little new data have been generated on the toxicity of imidacloprid to birds and mammals since the Agency's most recent ecological risk assessments. The Agency therefore will rely on its previously conducted assessments for characterizing the risk of imidacloprid to non-insect terrestrial organisms. For its final ecological risk assessment, the Agency will fully evaluate risks to birds, mammals, and terrestrial plants."

Not only is this an underestimation of the research that has emerged showing risks to non-aquatic species—particularly birds, which are impacted by the use of neonicotinoid chemicals as shown in the findings of the comprehensive Palmer and Mineau report, *The Impact of the Nation's Most Widely Used Insecticides on Birds*—but it also is a setback in finalizing the registration review and initiating regulatory action on these environmental contaminants. [63] **Rather than wait on the full ecological risk assessment, EPA should recognize the risks to aquatic species as well as the interconnection of aquatic and terrestrial environments and immediately restrict uses of imidacloprid**

6. No Endangered Species Act Analysis

EPA acknowledges the lack of Endangered Species Act analysis stating:

> *"Given that the agencies are continuing to develop and work toward implementation of the Interim Approaches to assess the potential risks of pesticides to listed species and their designated critical habitat, this ecological problem formulation supporting the Preliminary Work Plan for imidacloprid does not describe the specific ESA analysis, including effects determinations for specific listed species or designated critical habitat, to be conducted during registration review".*

However, with the documented contamination of neonicotinoids and proposed concerns to aquatic ecosystems, **it is critical that EPA act quickly and include a thorough analysis of potential threats to species listed through the Endangered Species Act**

7. Strong Evidence of Risk, Yet No Regulatory Action

EPA concluded in their risk assessment (emphasis added):

> "*It is evident, however that **concentrations of imidacloprid** detected in streams, rivers, lakes and drainage canals **routinely exceed acute and chronic toxicity endpoints** derived for freshwater invertebrates"*

Based on the substantial impacts to aquatic invertebrates, including ESA-protected species, happening on a wide scale by registered uses, **it is clear that EPA needs to take immediate action to restrict uses of imidacloprid and other neonicotinoid insecticides to prevent further damage to ecosystem services**.

Furthermore, EPA identifies that:

> *"..the risk findings summarized in this assessment are in general agreement with recent findings published by Canada's Pest Management Regulatory Agency and the European Food Safety Authority"*

EPA should follow PMRA's example in proposing a prompt full phase out of imidacloprid for agricultural and outdoor uses. PMRA recognizes that due to imidacloprid's persistence and water solubility that regional restrictions will not be sufficient in mitigating risks. **EPA needs to enforce strong action now, to prevent continued, potentially irreparable, damages to vulnerable species and ecosystems.**

Recommendations to EPA

1. EPA in the final risk assessment should more accurately portray the risk posed by seed-coatings and include a thorough field realistic analysis of all neonicotinoid chemicals.

2. EPA should update water quality benchmarks for imidacloprid using proposed thresholds and include mandated neonicotinoid testing in their final risk assessment.

3. EPA's final risk assessment should include a comprehensive examination of the threats from additive and synergistic effects of combined exposure to multiple pesticides.

4. It is critical that EPA include higher-tier and mesocosm analysis to fully determine the risk to fish, amphibian, and bird species. EPA should also complete a thorough analysis of potential threats to species listed through the Endangered Species Act in the final risk assessment.

5. EPA should not wait on the proposed timeline for the final risk assessment. Rather EPA needs to enforce strong action now and restrict uses of imidacloprid and other neonicotinoid insecticides to prevent continued, potentially irreparable, damages to vulnerable ecosystems.

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