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Ecotoxicology and indirect effects

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Details of the Deep Dive

Topic: Environmental risk assessment, ecotoxicology, indirect effects
Thematic area(s): Environmental risk assessment (ERA)
Keyword(s): NA
Query: biodiversity trophic environmental pesticide GMO ecotoxicology interaction concerns issues
Timeframe: 2023 - present

A. Deep dive general introduction

The European Commission has directed the European Food Safety Authority (EFSA) to revise the Terrestrial Ecotoxicology Guidance Document, which was initially established in 2002, in light of the increasing demand for conservation strategies and the evolving environmental challenges. The primary objective of this revision is to establish guidelines for evaluating the potential indirect effects on biodiversity that may result from trophic interactions in agro-environmental conditions.

The objective of this deep dive is to offer a thorough comprehension of the positions and concerns of EFSA's partners and stakeholders with respect to these indirect impacts on biodiversity.

B. Distilled information

B1. Key actors position as identified by EFSA

European Commission (EC) endorses the notion that technological advancements in agriculture may result in intensive agricultural practices that degrade natural habitats, despite their potential to increase productivity. If not managed responsibly, the adoption of genetically modified (GM) crops and new agricultural techniques can disrupt market dynamics and resource utilisation, potentially having a detrimental impact on biodiversity. Furthermore, the health of ecosystems and the biodiversity they sustain are further jeopardised by soil degradation and water contamination resulting from environmental pollution caused by agricultural runoff and industrial refuse. EC promotes the implementation of comprehensive and integrated strategies in agricultural practices and policy-making to reduce the unintended consequences on biodiversity. In order to advance agricultural productivity while ensuring the health of ecosystems, it is necessary to implement measures that promote ecological balance and sustainability and to carefully consider these indirect effects (Europe, 2023) promotes the implementation of comprehensive and integrated strategies in agricultural practices and policy-making to reduce the unintended consequences on biodiversity. In order to advance agricultural productivity while ensuring the health of ecosystems, it is necessary to implement measures that promote ecological balance and sustainability and to carefully consider these indirect effects (European Commission, 2023).

The European legislation is criticised by the **Pesticide Action Network Europe** (PAN) for failing to adequately acknowledge the risks associated with AMPA (aminomethylphosphonic acid), a metabolite of glyphosate. The PAN asserts that the toxicological impact of these chemicals on aquatic environments may be underestimated by the current regulations. It asserts that the safety limits for glyphosate and AMPA should be uniformly reduced to safeguard ecosystems, highlighting the discrepancies between waters designated for human consumption and those that are not. This perspective highlights the necessity of more rigorous and consistent legislation to protect European ecosystems and waters (Pesticide Action Network Europe, 2023).

US EPA explores the extensive utilisation of herbicides and their application methods, which have the potential to significantly contaminate watercourses and damage aquatic flora and fauna. However, there is also an implicit critique of current regulations in this context, which implies that the current measures are insufficient to prevent water contamination and the resulting damage to ecosystems. The text argues for a more precautionary approach to the regulation of herbicides, with a particular emphasis on the adverse effects of their combination with other pesticides (The United States Environmental Protection Agency, 2024).

Wageningen University & Research: A number of recent studies, particularly those conducted by Wageningen University & Research (WUR), have provided important insights into the potential indirect effects on biodiversity

through trophic interactions under agro-environmental conditions, in the complex interplay between agricultural practices and biodiversity. The necessity of multi-sectoral cooperation and integrative scientific studies to mitigate the cascading impacts of agricultural practices on ecosystem health is emphasised by the integrated approach discussed in the WUR website (Wageningen University & Research, a). In the same way, ongoing WUR projects (Wageningen University & Research, b) delve into the development of sustainable protein production systems that reduce the demand on traditional crops and livestock, while also utilising alternative sources such as microorganisms and insects to minimise pollution. This approach has the potential to alleviate the strain on biodiversity.

The significance of incorporating ecological and behavioural sciences to develop more sustainable pest management strategies that consider broader ecological consequences, such as the disruption of beneficial insect populations, is underscored by the implications of pesticide use, as examined in a recent WUR longread (Wageningen University & Research, c). At the same time, (Wageningen University & Research, d) introduces an environmental simulation tool that assists in the evaluation of the indirect impacts of agricultural practices on biodiversity, specifically the impact of nutrient management on soil microfauna and water uses on aquatic ecosystems. A recent dossier (Wageningen University & Research, e) and interview (Wageningen University & Research, f) insists on a fair assessment of the ecological repercussions of genetically modified crops on trophic dynamics and biodiversity, emphasising the potential of CRISPR-Cas technology in the development of crop varieties that are resilient to environmental stresses such as drought. Another longread (Wageningen University & Research, g) conducts a critical analysis of the role of water management in the development of sustainable food systems, with a particular emphasis on the interdependencies between biodiversity, food production, and water use.

The efforts to incorporate biodiversity considerations into food system innovation are detailed in a specific webpage (Wageningen University & Research, h), which aims to reduce biodiversity loss and improve ecosystem services. This is exemplified in a research institute webpage (Wageningen University & Research, i), where the use of molecular genetics to develop crops that are resistant to insects and fungi has the potential to reduce the reliance on chemical pesticides, thereby indirectly benefiting biodiversity. The potential repercussions of a complete ban on glyphosate, as discussed in a news of October 2023 (Wageningen University & Research, j), underscore the necessity of location-specific approaches and additional technological advancements to effectively reduce herbicide use. This could potentially result in more sustainable agricultural practices with fewer unintended impacts on biodiversity.

The concept of food forests and agroforestry is the subject of an impact story (Wageningen University & Research, k), which delves into the inventive agricultural practices that contribute to biodiversity restoration and offer a novel approach to enhancing trophic interactions. Another more recent news (Wageningen University & Research, l) emphasises the necessity of sustainable control strategies that maintain ecological balance and soil health, while also addressing the threat of root-knot and cyst nematodes.

A news from February 2024 (Wageningen University & Research, m) focus on the ecological risk evaluation of microplastics in soil, emphasising the potential disruption of soil ecosystems and trophic interactions as a result of microplastic ingestion by soil organisms while a dossier (Wageningen University & Research, n) explores the potential of insects as sustainable protein sources, thereby mitigating the ecological consequences of conventional livestock production.

Collectively, these documents from WUR contribute to the broader discourse on the indirect impact of agricultural practices and innovations on biodiversity through changes in pest management strategies, crop genetic diversity, and land use practices. This underscores the significance of considering ecological and trophic interactions in agricultural research and policy development.

Alternative agricultural practices

OECD: In alignment with current legislative directives, such as EU Directive 91/414/EEC and regulation EC 1107/2009, the use of baculoviruses as biocontrol agents is recognized for its safety and efficacy, promoting a shift towards sustainable agricultural practices (OECD, 2023). These biocontrol agents provide a precision approach to pest management, reducing reliance on chemical pesticides and supporting biodiversity.

Wageningen University & Research: Similarly, the dairy sector is exploring sustainable practices to mitigate environmental impacts, such as methane reduction and soil quality improvements. These efforts are crucial for enhancing biodiversity and implementing sustainable dairy farming methods (Wageningen University & Research, o). Additionally, the Re-Ge-NL program in the Netherlands exemplifies this sustainable transition by focusing on regenerative agriculture, aiming to restore ecosystems while improving the economic position of farmers (Wageningen University & Research, p).

Species-specific information

Health Canada: Two recent case studies from Canada underscore the substantial obstacles to wildlife conservation that are a result of human-induced hazards. Despite the fact that this is not exclusively associated with trophic interaction, it is still relevant because of the player's significance. The Sea Otter is the primary focus of the initial case. This species is highly susceptible to oil contamination, primarily as a result of its reliance on fur for isolation and its sex segregated behaviour in large groups. The risk of oil accidents that could impact vast areas of its habitat is elevated by increased transport activity. Contaminants, entanglement in fishing gear, persecution, climate change, ship collisions, pathogens, and human disturbances are additional threats (Health Canada, a).
The second case pertains to migratory bats that are at a high risk of mortality in wind farms, a hazard that may be exacerbated by the anticipated expansion of wind capacity. The number of carcasses at wind farms indicates a population decline that is alarming, with a rate of over 50% over three generations. Additionally, these bats are subject to pollution, forest habitat loss, and a decline in insect populations. Population viability models indicate that a critical extinction threshold may be achieved by 2050 if current trends persist (Health Canada, b).

B2. Additional position of non-key actors

In this section, we included additional information from non-actor organisations that emerged during the search. Other sources have been consulted but not reported for sake of clarity.

Scotland's Nature Agency (NatureScot) reports that the primary objective of the rigorous evaluation procedure for herbicides is to guarantee the safety of individuals who are directly exposed, including workers and nearby residents. Nevertheless, the broader environmental assessments are restrictive in nature, particularly in terms of aquatic bodies and wildlife, and they fail to adequately address the issues related to nature conservation. Research has demonstrated that herbicides can have substantial and detrimental effects on a diverse array of organisms, suggesting that the current testing protocols may not be sufficient to anticipate or mitigate these effects. NatureScot, in compliance with the Sustainable Use Directive (2009/128/EC), prioritises non-chemical methods and emphasises the reduction of pesticide use, positioning pesticides as a last resort. Mechanical weeding, biological controls, and the development of resistant crop varieties are prioritised over chemical interventions in this approach. This method is a component of a more comprehensive strategy to integrate pest management that is designed to reduce the overall reliance on pesticides by advocating for the development of biocontrol and low-risk substances and targeted application methods that take into account the indirect effects on biodiversity. NatureScot advocates for a comprehensive approach to Integrated Pest Management (IPM) that encompasses the development of biocontrol methods and low-risk substances, as well as targeted application methods that account for the indirect effects on biodiversity. These procedures are a component of a more comprehensive approach to pest management that aims to reduce the reliance on chemical pesticides. NatureScot suggests that land managers, advisers, and authorities conduct routine audits of the areas surrounding herbicide applications to practically implement these strategies, establish buffer zones to safeguard sensitive environments, and ensure that trained personnel use approved, low-risk pesticides. These measures are intended to reduce the unintended effects on biodiversity, thereby promoting a more sustainable relationship between agriculture and natural ecosystems. (Scotland's Nature Agency, 2024) (Scotland's Nature Agency, 2023).

C. Monitoring timelines

The time period covered by the following deepening is from 1 January 2023 to 03 October 2024.

D. Key actors and roles

Organization	Number of documents cited	Main topic of the article(s) cited
European Commission	1	Report
Health Canada	2	Species-specific information
Pesticide Action Network Europe	1	Report
The Organisation for Economic Co-operation and Development	1	Possible alternatives
The United States Environmental Protection Agency	1	Critical issues
Wageningen University & Research	16	Critical issues, Possible alternatives, Innovative techniques

E. Key insights and recommendations

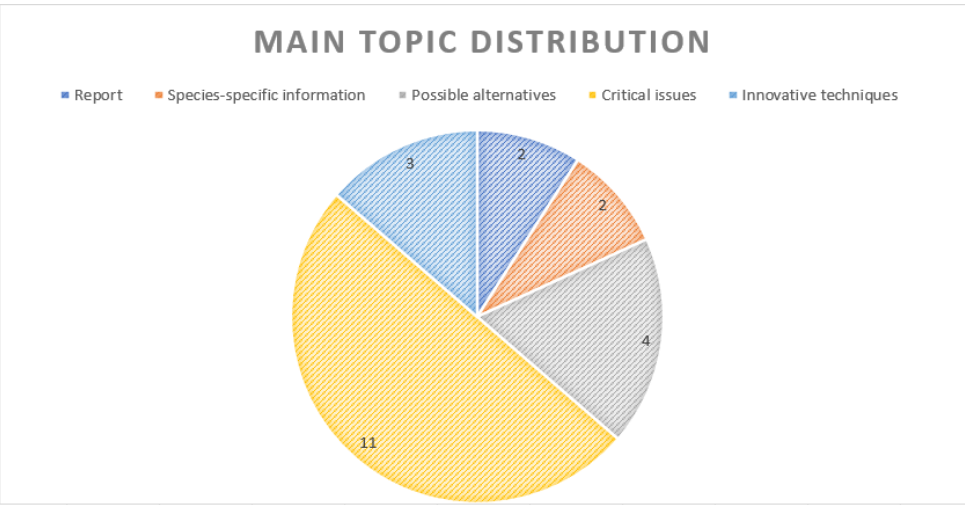
Insights:

- **Technological Advancements**: While aimed at increasing agricultural productivity, may lead to intensive practices that degrade natural habitats and disrupt market dynamics and resource utilization, negatively impacting biodiversity.
- **Soil and Water Contamination**: Environmental pollution from agricultural runoff and industrial refuse further jeopardizes ecosystem health.
- **Persistent Organic Pollutants**: Chemicals like AMPA (a glyphosate metabolite) pose underacknowledged risks due to their toxicological impact on aquatic environments.
- **Inadequate Regulations**: Current regulations may not adequately prevent the contamination of watercourses by herbicides, which can harm aquatic flora and fauna.
- **Need for Ecological Consideration in Pest Management**: The integration of ecological and behavioural sciences is crucial for developing sustainable pest management strategies that consider broader ecological consequences.

Recommendations:

- **Implement Comprehensive Strategies**: Agricultural practices and policymaking should integrate comprehensive strategies to reduce unintended consequences on biodiversity (European Commission, 2023).
- **Strengthen Regulations**: Enhance the rigor and consistency of legislation to better protect ecosystems from chemical pollutants (Pesticide Action Network Europe, 2023).
- **Adopt Precautionary Regulatory Approaches**: Update herbicide regulations to reflect a precautionary approach that accounts for the cumulative effects of pesticides (The United States Environmental Protection Agency, 2024).
- **Promote Ecological Balance and Sustainability**: Encourage measures that ensure ecosystem health, focusing on ecological balance and sustainability to mitigate indirect effects on biodiversity (European Commission, 2023).
- **Monitor and Evaluate New Agricultural Techniques**: Carefully assess the ecological repercussions of genetically modified crops and other innovative farming techniques on biodiversity and trophic dynamics (Wageningen University & Research, f).

F. Document analytics



This pie chart visually represents the distribution of main topics across the documents. Half of the document cited address critical issues, while a smaller proportion discuss potential alternatives or innovative technologies.

G. Concise summary

The intricate relationship between environmental sustainability and technological advancements in agriculture have emerged. It underscores the apprehension that the degradation of natural habitats and the disruption of biodiversity may result from innovations such as genetically modified crops and new agricultural techniques in the absence of responsible management. The necessity of integrated strategies in agricultural policy-making to mitigate unintended ecological impacts is underscored. Agricultural runoff and the use of persistent organic contaminants are among the primary concerns, which include the contamination of water bodies and soil degradation. The deep dive reflects a push for the implementation of more stringent regulations and the implementation of sustainable practices that account for the direct and indirect impacts of agriculture on ecosystems. In general, it promotes the maintenance of ecological health while simultaneously increasing agricultural productivity to guarantee long-term sustainability.

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