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Examining the management of road verges and weedy areas in the Municipality are of the City of Cape Town: A summary of some documented impacts of the herbicide Roundup (and its active ingredient glyphosate) and an argument to curtail its use within the City of Cape Town

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1) INTRODUCTION

This memorandum provides a short summary of some of the relevant published studies and published public commentary around the use of Roundup, a pesticide/herbicide (weed killer) widely used by the City of Cape Town to manage road verges and other weed control issues. This memorandum is specifically focussed on increased international scrutiny of Roundup/ Glyphosate as a chemical formulation of concern as we believe that the continued use of this and other herbicides at current levels is inadvisable, for several reasons.

It is notable that the current owner of the corporation that developed Roundup, Monsanto, Bayer Corporation has recently offered to settle over 125, 000 cancer suits in the USA linked to the use of Roundup (https://www.independent.co.uk/news/business/news/bayer-roundup-weedkiller-cancerlawsuits-settlement-a9531821.html) for over $10bn. From this it is evident that any agency continuing use of this family of chemicals (and any other chemicals implicated in health risks for that matter) is at risk being cited as a co-applicant if they are aware of such risk, should harm to people or the environment occur. It therefore would appear to be advisable to assume a precautionary approach in the use of any such chemicals.

While those producing these chemicals, their agents selling or applying them or even regulatory agencies involved in managing them may assert the safety of these chemicals, if and when the established or evolving science demonstrates unacceptable levels of risk then again, precaution is advisable. It is further notable that recent legal trials around Roundup use and its links to cancer in the USA have demonstrated direct interference in the regulatory process and in the writing and publication of articles that are supportive of their commercial interests (see Krimsky, S & C. Gillam.

2018. Roundup litigation discovery documents: implications for public health and journal ethics. *Journal of Public Health Policy*[1], (39)318–326: https://link.springer.com/article/10.1057/s41271-0180134-z).

South Africa has a weak and compromised chemical regulatory system. Industry continues to have inordinate influence over the regulatory process, to the extent that the pesticide industry through its lobby agency Croplife holds powerful sway over the process, which it seeks to deepen[2] [3]. These compromises, combined with the primary regulatory law dating back to 1947, provide insufficient protections against the evolving risk from the use of various pesticides and other industrial chemicals to South Africans. Consequently numerous increasingly concerned and active groups within civil society are pursuing these matters and seek to challenge the unacceptable current situation both through regulatory reform and through direct legal action.

As a result of the inherent risks of Roundup use, countries such as Germany (https://www.reuters.com/article/us-germany-farming-lawmaking/german-cabinet-approveslegislation-to-ban-glyphosate-from-2024-idUSKBN2AA1GF), SriLanka, (http://www.sundaytimes.lk/150614/news/its-official-glyphosate-import-is-banned-153388.html), France (tinyurl.com/2sbsaese) and Mexico (https://www.ipsnews.net/2021/02/mexico-banglyphosate-gm-corn-presidential-decree-comes-despite-intense-pressure-industry-u-s-authorities/), as well as cities like Rotterdam (https://rotterdam.nieuws.nl/nieuws/5655/rotterdam-centrum-bantomstreden-bestrijdingsmiddel-roundup/) and others have moved to ban or seriously restrict the use of these chemicals in their nations and cities.

In light of the above we suggest that the City of Cape Town carefully re-examine its policy regarding pesticide use, particularly in areas where runoff threatens areas of high conservation value or which contain protected species. There is pressure from both an increasingly informed citizenry and from specialists working in these areas to reduce or curtail the wholesale use of chemicals that are used without due consideration of the broader impacts. We fully realise there may be operational considerations and obligations for the city. We will therefore provide a brief summary of alternatives after summarising some of the risks of Roundup/ Glyphosate below.

2) SOME RISKS OF ROUNDUP / GLYPHOSATE TO SPECIES AND THE LIVING ENVIRONMENT

2.1) US EPA finds glyphosate is likely to injure or kill 93% of endangered species

[1] This paper reviews the court-released discovery documents obtained from litigation against Monsanto over its herbicide Roundup and through Freedom of Information Act requests (requests to regulatory agencies and public universities in the United States). We sought evidence of corporate malfeasance and undisclosed conflicts of interest with respect to issues of scientific integrity. The findings include evidence of ghostwriting, interference in journal publication, and undue influence of a federal regulatory agency.

[2] Africa must act on pesticide 'double standards'. https://mg.co.za/article/2020-03-05-africa-must-act-onpesticide-double-standards/

[3] Uncovered: the pesticide lobby's plan to snatch power over South African science. https://unearthed.greenpeace.org/2020/12/11/lobbyists-pesticides-south-africa-syngenta-bayer-science/

In 2020 the US Environmental Protection Agency (EPA) released a draft biological evaluation[4] which found that glyphosate is likely to injure or kill 93% of the plants and animals protected under the Endangered Species Act.

This long-anticipated evaluation, released by the agency's pesticide office, found that 1,676 endangered species are likely to be harmed by glyphosate, the active ingredient in Roundup, the world's most-used pesticide. The evaluation also found that glyphosate adversely modifies critical habitat for 759 endangered species, or 96% of all species for which critical habitat has been designated.

"The hideous impacts of glyphosate on the nation's most endangered species are impossible to ignore now," said Lori Ann Burd, environmental health director at the Center for Biological Diversity. "Glyphosate use is so widespread that even the EPA's notoriously industry-friendly pesticide office had to conclude that there are hardly any endangered species that can manage to evade its toxic impacts."

This if of direct relevance to us in South Africa in general and the Western Cape in particular, where we have some of the highest levels of biodiversity and endemism (species located only here) on earth. There are ever increased pressures on the ecosystems within the City which continue to drive biodiversity loss. It is therefore incumbent upon the City to properly manage its responsibilities in this regard.

The University of Birmingham has also written of these concerns. Their research shows that even at approved regulatory levels, the Roundup causes embryonic development failure, significant DNA damage, and also interferes with the metabolism and gut function of insects[5].

2.2) Impact on fish

We provide a short summary of some relevant studies on the impacts of Roundup/ Glyphosate on some insect species. It appears these effects may be replicated across other insect species beside bees, increasing the chances of ecosystem disruption through trophic cascades, as many other animals such as birds, fish, amphibians and reptiles interact and rely on insects for food and other lifecycle support.

There are many other studies available besides the few cited; we provided a minimal cross section of the published literature for brevities sake. We can substantially supplement this literature if required.

a) Sampaio, R.A., et al. 2020. Is glyphosate toxic to bees? A meta-analytical review. Science of The Total Environment (767)

[4] Draft National Level Listed Species Biological Evaluation for Glyphosate. https://www.epa.gov/endangered-species/draft-national-level-listed-species-biological-evaluationglyphosate#executive-summary

[5] https://www.birmingham.ac.uk/news/latest/2020/12/new-research-highlights-impacts-of-weedkiller-onwildlife.aspx

https://doi.org/10.1016/j.scitotenv.2021.145397Get rights and content

Glyphosate (GLY) is an herbicide widely used in agriculture. First considered as non-toxic or slightly toxic to bees, GLY and its different formulations have shown, more recently, to affect negatively the survival, development and behavior of these insects, even when used in doses and concentrations recommended by the manufacturer. Thus, the results of research on the toxicity of GLY to bees are often conflicting, which makes a meta-analysis interesting for data integration, generating a statistically reliable result. Therefore, this study aimed to evaluate the GLY effects on mortality of bees through a meta-analysis. For this, a search was carried out in the databases Web of Science, CAPES (Coordination for the Improvement of Higher Education Personnel - Brazil), Scopus, and PubMed. Papers that evaluated the effect of GLY on bee mortality published between 1945 and October 2020, were considered. After obtaining the data, R software was used to perform the metaanalytical tests. Sixteen papers on mortality were selected with 34 data sets. Most of the sets demonstrated differences between the control and experimental groups, showing that the treatments with GLY caused higher mortality of bees. The results considering the methodology used (ingestion or contact), the phase of the biological cycle (adults or larvae), and the dose (ecologically relevant dose and recommended by the manufacturer) were different when compared with their respective control groups. Therefore, GLY can be considered toxic to bees. It is important to emphasize that this meta-analysis identified that papers assessing the toxicity of GLY to bees are still scarce, for both lethal and sublethal effects, mainly for stingless and solitary bee species.

b) Dai, P, et al. 2018. The Herbicide Glyphosate Negatively Affects Midgut Bacterial Communities and Survival of Honey Bee during Larvae Reared in Vitro. Journal of Agricultural and Food Chemistry. (66:29) 7786–7793

Effects of glyphosate on survival, developmental rate, larval weight, and midgut bacterial diversity of *Apis mellifera* were tested in the laboratory. Larvae were reared *in vitro* and fed diet containing glyphosate 0.8, 4, and 20 mg/L. The dependent variables were compared with negative control and positive control (dimethoate 45 mg/L). Brood survival decreased in 4 or 20 mg/L glyphosate treatments but not in 0.8 mg/L, and larval weight decreased in 0.8 or 4 mg/L glyphosate treatments. Exposure to three concentrations did not affect the developmental rate. Furthermore, the intestinal bacterial communities were determined using high-throughput sequencing targeting the V3–V4 regions of the 16S rDNA. All core honey bee intestinal bacterial phyla such as Proteobacteria (30.86%), Firmicutes (13.82%), and Actinobacteria (11.88%) were detected, and significant changes were found in the species diversity and richness in 20 mg/L glyphosate group. Our results suggest that high concentrations of glyphosate are deleterious to immature bees.

c) Motta, E. V. S, Raymann, K, Moran, N.A. 2018. Glyphosate perturbs the gut microbiota of honey bees. PNAS (115:41) 10305-10310 https://doi.org/10.1073/pnas.1803880115

Increased mortality of honey bee colonies has been attributed to several factors but is not fully understood. The herbicide glyphosate is expected to be innocuous to animals, including bees, because it targets an enzyme only found in plants and microorganisms. However, bees rely on a specialized gut microbiota that benefits growth and provides defense against pathogens. Most bee gut bacteria contain the enzyme targeted by glyphosate, but vary in whether they possess susceptible versions and, correspondingly, in tolerance to glyphosate. Exposing bees to glyphosate

alters the bee gut community and increases susceptibility to infection by opportunistic pathogens. Understanding how glyphosate impacts bee gut symbionts and bee health will help elucidate a possible role of this chemical in colony decline.

2.3) Impacts on other insects-Daphnia, a key water dwelling insect, critical to food web

a) Suppa, A. et al. 2020. Roundup causes embryonic development failure and alters metabolic pathways and gut microbiota functionality in non-target species. Microbiome, (8) 170.

Our results show that chronic exposure to concentrations of Roundup and glyphosate at the approved regulatory threshold for drinking water causes embryonic development failure and alteration of key metabolic functions via direct effect on the host molecular processes and indirect effect on the gut microbiota. The ecological model species *Daphnia* occupies a central position in the food web of aquatic ecosystems, being the preferred food of small vertebrates and invertebrates as well as a grazer of algae and bacteria. The impact of the weedkiller on this keystone species has cascading effects on aquatic food webs, affecting their ability to deliver critical ecosystem services.

2.4) Impact on Amphibians

In Cape Town with its extensive wetland zones, the impact of Roundup on amphibians is of high interest and concern. It is notable that several studies have shown serious impacts of Roundup on amphibians, particularly in early stage development, for example:

a) Relyea, R. 2005. The Lethal Impact of Roundup on Aquatic and Terrestrial Amphibians. Ecological Applications. (15:4) 1118-1124. https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1890/04-1291

The global decline in amphibian diversity has become an international environmental problem with a multitude of possible causes. There is evidence that pesticides may play a role, yet few pesticides have been tested on amphibians. For example, Roundup is a globally common herbicide that is conventionally thought to be nonlethal to amphibians. However, Roundup has been tested on few amphibian species, with existing tests conducted mostly under laboratory conditions and on larval amphibians. Recent laboratory studies have indicated that Roundup may be highly lethal to North American tadpoles, but we need to determine whether this effect occurs under more natural conditions and in post-metamorphic amphibians. I assembled communities of three species of North American tadpoles in outdoor pond mesocosms that contained different types of soil (which can absorb the pesticide) and applied Roundup as a direct overspray. After three weeks, Roundup killed 96–100% of larval amphibians (regardless of soil presence). I then exposed three species of juvenile (post-metamorphic) anurans to a direct overspray of Roundup in laboratory containers. After one day, Roundup killed 68–86% of juvenile amphibians. These results suggest that Roundup, acompound designed to kill plants, can cause extremely high rates of mortality to amphibians that could lead to population declines.

b) Singh, Y., Giri, S., Utsab, S., Boro, F., Giri, A. 2013. Toxic and genotoxic effects of Roundup on tadpoles of the Indian skittering frog (*Euflictis cyanophlyctis*) in the presence and absence of predator stress. Aquatic Toxicology (132/13, 1-8.

Glyphosate, a post emergent herbicide, has become the backbone of no-till agriculture and is considered safe for animals. However, the impact of glyphosate on non-target organisms, especially on amphibians, is the subject of major concern and debate in recent times. We examined the toxic and genotoxic effects of Roundup, a commercial formulation of glyphosate, in the tadpoles of the Indian skittering frog (*Euflictis cyanophlyctis*). Presence of predator stress apparently increased the toxicity and genotoxicity of Roundup; but these effects were not statistically significant. These findings suggest that Roundup at environmentally relevant concentrations has lethal and genotoxic impact on *E. cyanophlyctis*; which may have long-term fitness consequence to the species.

c) Meza-Joya, F. L., Ramierez-Pinilla, M. P., Fuentes-Lorenzo, J. L. 2013. Toxic, cytotoxic, and genotoxic effects of a glyphosate formulation (Roundup®SL–Cosmoflux®411F) in the directdeveloping frog *Eleutherodactylus johnstonei.* Environmental and Molecular Mutagenesis, (54:5) 362-373. https://onlinelibrary.wiley.com/doi/abs/10.1002/em.21775

Glyphosate formulation at application rates above 5.4 µg a.e./cm^2 (in vivo) and concentrations above 95 µg a.e./mL (in vitro) showed clear evidence of cytotoxicity. In vivo and in vitro exposure of *E. johnstonei* erythrocytes to the glyphosate formulation induced DNA breaks in a dose-dependent manner with statistically significant values ($P < 0.05$) at all doses tested. DNA damage initially increased with the duration of exposure and then decreased, suggesting that DNA repair events were occurring during in vivo and in vitro exposures. These results are discussed from the perspective of possible ecotoxicological risks to anuran species from exposure to glyphosate formulation.

Therefore clear evidence exists of genotoxicity and other impacts of Roundup on Amphibians.

2.5) Impact on Fish

a) Cavalcante, D., Martinez, C., Sofia, S. H. 2008. Genotoxic effects of Roundup® on the fish *Prochilodus lineatus*. Mutation Research/Genetic Toxicology and Environmental Mutagenesis (655:1-2) 41-46.

https://www.sciencedirect.com/science/article/abs/pii/S1383571808001794

Glyphosate-based herbicides, such as Roundup®, represent the most extensively used herbicides worldwide, including Brazil. Despite its extensive use, the genotoxic effects of this herbicide are not completely understood and studies with Roundup® show conflicting results with regard to the effects of this product on the genetic material. Thus, the aim of this study was to evaluate the genotoxic effects of acute exposures (6, 24 and 96 h) to 10 mg L^{-1} of Roundup® on the neotropical fish *Prochilodus lineatus*. The frequencies of micronucleus and other erythrocyte nuclear abnormalities (ENAs) were not significantly different between Roundup® exposed fish and their respective negative controls, for all exposure periods. In conclusion, the results of this work showed that Roundup® produced genotoxic effects on the fish species *P. lineatus*. The comet assay with gill cells showed to be an important complementary tool for detecting genotoxicity, given that it revealed DNA damage

in periods of exposure that erythrocytes did not. ENAs frequency was not a good indicator of genotoxicity, but further studies are needed to better understand the origin of these abnormalities.

2.6) Impacts of Roundup/ Glyphosate on Reptiles

a) Burella, P. M., Simoniellw, M. F., Poletta, G. L. 2017. Evaluation of Stage-Dependent Genotoxic Effect of Roundup (Glyphosate) on Caiman latirostris Embryos. Arch Environ Contam Toxicol (72) 50–57.

A statistically significant difference in DNA damage … was found between groups exposed to different concentrations of Roundup and the negative control, but no difference was observed among the three stages of exposure within any treatment. The results obtained in this study indicate that Roundup produce DNA damage on C. latirostris embryos independently of the developmental stage where the exposure occurs, implying an important risk for the species during all its period of development, when pesticide application is at maximum rate.

While there are no alligators in the study area there are extensive numbers and species of reptiles and amphibians such as lizards, skinks, tortoises, turtles, geckoes and snakes, several of which are under threat.

Consequently we would suggest that the use of Roundup in any areas which may impact runoff to streams, ponds or wetlands of concern should be forbidden because of the impact of the chemical formulation on insects, amphibians, reptiles and fish.

3) Impact on Humans

First, it is critical to note that Monsanto, the developer of Roundup, has for decades obscured the facts and truth behind the risks of Roundup. The company, since sold to Bayer, faces thousands of lawsuits over its carcinogenicity, with the first being settled in the USA at many million-dollar costs to Bayer. The stock price of Bayer has plummeted[6] since it bought Monsanto largely because of these ongoing associated risks to the extent that shareholders are now threatening to sue its board.

These court cases brought against Bayer/ Monsanto have exposed numerous hidden studies which illustrated the degree to which Monsanto covered up the risks of this product. Roundup is the new tobacco, with ongoing and increasing liabilities for its parent company Bayer, which desperately seeks to extricate itself from this problem.

While some of these studies have been on animals other than humans, it is common practice to experiment on animals to ascertain possible negative human impacts. Thus by extension many of the studies above and below have direct relevance to human health.

[6] Bayer sued by shareholders over Monsanto acquisition. 2 Feb, 2021. "The share price of the Bayer group including the Crop Science and pharma divisions has almost halved since the takeover of Monsanto in June 2018." https://chemweek.com/CW/Document/117073/Bayer-sued-by-shareholders-over-Monsantoacquisition

3.1) Krimsky, S & C. Gillam. 2018. Roundup litigation discovery documents: implications for public health and journal ethics. *Journal of Public Health Policy, (*39)318–326.

https://link.springer.com/article/10.1057/s41271-018-0134-z

This paper reviews the court-released discovery documents obtained from litigation against Monsanto over its herbicide Roundup and through Freedom of Information Act requests (requests to regulatory agencies and public universities in the United States). We sought evidence of corporate malfeasance and undisclosed conflicts of interest with respect to issues of scientific integrity. The findings include evidence of ghost-writing, interference in journal publication, and undue influence of a federal regulatory agency. This is not simply a case of omission by Monsanto to mention the risk but shows a repeated pattern of cover-up, collusion and lobbying to protect and secure its commercial interests.

3.2) Genotoxicity

This is a crucial area of concern as any disruption of genomes stands to increase the risk of untoward events such as cancer, or of impact on future generations through transmission of genetic disruption. Neither is this anything new, with some published data reaching into the 20th century, for example:

a) Bolognesi, C., et al. 1997. Genotoxic Activity of Glyphosate and Its Technical Formulation Roundup*J. Agric. Food Chem.* 1997 (45; 5) 1957–1962. https://doi.org/10.1021/jf9606518

Glyphosate (*N*-phosphonomethylglycine) is an effective herbicide acting on the synthesis of aromatic amino acids in plants. The genotoxic potential of this herbicide has been studied: the results available in the open literature reveal a weak activity of the technical formulation. In this study, the formulated commercial product, Roundup, and its active agent, glyphosate, were tested in the same battery of assays for the induction of DNA damage and chromosomal effects *in vivo* and *in vitro*. A DNA-damaging activity as DNA single-strand breaks and 8-OHdG and a significant increase in chromosomal alterations were observed with both substances *in vivo* and *in vitro*. A weak increment of the genotoxic activity was evident using the technical formulation.

However more recent data illustrates increased genotoxic risk and concerns:

b) Cavalcante, D., Martinez, C., Sofia, S. H. 2008. Genotoxic effects of Roundup® on the fish *Prochilodus lineatus*. Mutation Research/Genetic Toxicology and Environmental Mutagenesis (655:1-2) 41-46.

https://www.sciencedirect.com/science/article/abs/pii/S1383571808001794

Glyphosate-based herbicides, such as Roundup®, represent the most extensively used herbicides worldwide, including Brazil. Despite its extensive use, the genotoxic effects of this herbicide are not completely understood and studies with Roundup® show conflicting results with regard to the effects of this product on the genetic material. Thus, the aim of this study was to evaluate the genotoxic effects of acute exposures (6, 24 and 96 h) to 10 mg L^{-1} of Roundup® on the neotropical fish *Prochilodus lineatus*. Accordingly, fish erythrocytes were used in the comet assay, micronucleus test and for the analysis of the occurrence of nuclear abnormalities and the comet assay was adjusted for

branchial cells. The results showed that Roundup® produces genotoxic damage in erythrocytes and gill cells of *P. lineatus*. The comet scores obtained for *P. lineatus* erythrocytes after 6 and 96 h of exposure to Roundup® were significantly higher than respective negative controls. For branchial cells comet scores were significantly higher than negative controls after 6 and 24 h exposures. The frequencies of micronucleus and other erythrocyte nuclear abnormalities (ENAs) were not significantly different between Roundup® exposed fish and their respective negative controls, for all exposure periods. In conclusion, the results of this work showed that Roundup® produced genotoxic effects on the fish species *P. lineatus*. The comet assay with gill cells showed to be an important complementary tool for detecting genotoxicity, given that it revealed DNA damage in periods of exposure that erythrocytes did not. ENAs frequency was not a good indicator of genotoxicity, but further studies are needed to better understand the origin of these abnormalities.

3.3) Impacts of Roundup/ Glyphosate on the gut microbiome

Just as this has been shown to be a risk to bees in the literature shared above, it is equally a risk to humans. It is important to know that Glyphosate was initially identified as a possibly useful antibiotic. As such it has a direct and well studied impact on bacteria and particularly those in the gut, as per these studies, mainly through a well known mechanism known as the shikimate pathway. The health of gut bacteria is essential to human metabolic health with related negative health issues such as mental health, brain function and nutritional uptake being directly related to gut microbiome health. Applicators are particularly at risk of these impacts, even with moderate protection as are the public through runoff, overspray or roadside or culvert foraging.

a) Rueda-Ruzafa, L., Cruz, F., Roman, P., Cardona. D. 2018. Gut microbiota and neurological effects of glyphosate. Neurotoxicology (75) 1-8.

There are currently various concerns regarding certain environmental toxins and the possible impact they can have on developmental diseases. Glyphosate (Gly) is the most utilised herbicide in agriculture, although its widespread use is generating controversy in the scientific world because of its probable carcinogenic effect on human cells. Gly performs as an inhibitor of 5enolpyruvylshikimate-3-phospate synthase (EPSP synthase), not only in plants, but also in bacteria. An inhibiting effect on EPSP synthase from intestinal microbiota has been reported, affecting mainly beneficial bacteria. To the contrary, Clostridium spp. and Salmonella strains are shown to be resistant to Gly. Consequently, researchers have suggested that Gly can cause dysbiosis, a phenomenon which is characterised by an imbalance between beneficial and pathogenic microorganisms. The overgrowth of bacteria such as clostridia generates high levels of noxious metabolites in the brain, which can contribute to the development of neurological deviations. This work reviews the impact of Gly-induced intestinal dysbiosis on the central nervous system, focusing on emotional, neurological and neurodegenerative disorders. A wide variety of factors were investigated in relation to brain-related changes, including highlighting genetic abnormalities, pregnancy-associated problems, diet, infections, vaccines and heavy metals. However, more studies are required to determine the implication of the most internationally used herbicide, Gly, in behavioural disorders.

Similar studies:

b) Aitbali, Y., et al. 2018. Glyphosate based- herbicide exposure affects gut microbiota, anxiety and depression-like behaviors in mice. Neurotoxicol Teratol (64) 44-49.

3.4) Carcinogenicity (cancer causing attributes) of Roundup/Glyphosate

The UN based IARC (International Agency for Research on Cancer), an agency based within the World Health Organisation (WHO), is the overarching international authority on carcinogenicity. In declared that Glyphosate was "probably carcinogenic in humans"[7]. While this finding has been vociferously opposed by the Chemical Industry and its numerous front groups, these criticisms have been effectively responded to and rebutted[8].

From a legal perspective the proof of carcinogenity has been cemented in the US legal system where as per the introduction, Bayer is on the hook for multi-billion Dollar settlements for cancer cases attributed to the use of Roundup, particularly non-Hodgkins Lymphoma. The pesticide industry continues to dispute the issue of carcinogenity. This dispute revolves primarily around what may appear to be arcane arguments as to how various substances are assessed.

The fact remains that rigorous interrogation of the issues in the US legal system have demonstrated and found sufficient proof that the chemical industry is broadly and Monsanto/ Bayer specifically are in the wrong. Consequently substantial damages have been awarded. There is nothing to prevent such a similar class action suit in South Africa. Any agency which has been seen to continue to endorse the use of a chemical that has even a slightly likelihood of toxicity or carcinogenity could equally be held liable and thus become financially compromised through legal process.

There are several other identified physiological impacts linked to use of Roundup/ Glyphosate including hepatoxicity (liver toxicity)[9], nephrotoxicity (kidney damage)[10]. It is notable that the published science, particularly in the past decade, has raised ongoing concerns of its impacts on humans and on the natural world that supports us. Ongoing research indicates Roundup as a combination of chemicals has been insufficiently studied. Roundup is primarily tested and regulated as pure Glyphosate, while in fact it contains many other additives, most of which are poorly researched and are often simply not disclosed at all. The synergistic impact of these chemical cocktails are insufficiently studied or analysed. This recent study provides further consideration.

a) Franke, A. A., L. Xingnan, Y. B.Shvetsov. J. F.Lai. 2021. Pilot study on the urinary excretion of the glyphosate metabolite aminomethylphosphonic acid and breast cancer risk: The Multiethnic Cohort study. Environmental Pollution (227).

https://www.sciencedirect.com/science/article/abs/pii/S0269749121004309

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[7] IARC Monograph on Glyphosate. https://www.iarc.who.int/featured-news/media-centre-iarc-newsglyphosate/

[8] IARC response to criticisms of the Monographs and the glyphosate evaluation. https://www.iarc.who.int/wpcontent/uploads/2018/07/IARC_response_to_criticisms_of_the_Monographs_and_the_glyphosate_evaluatio n.pdf

[9] Multiomics reveal non-alcoholic fatty liver disease in rats following chronic exposure to an ultra-low dose of Roundup herbicide. https://www.nature.com/articles/srep39328,
Glyphosate-induced lipid metabolism disorder contributes to hepatotoxicity in juvenile common carp. https://www.sciencedirect.com/science/article/abs/pii/S0269749120368755

[10] Comparative Assessment on Mechanism Underlying Renal Toxicity of Commercial Formulation of Roundup Herbicide and Glyphosate Alone in Male Albino Rat.
https://journals.sagepub.com/doi/full/10.1177/1091581818779553
Use of a glyphosate-based herbicide-induced nephrotoxicity model to investigate a panel of kidney injury biomarkers. https://www.sciencedirect.com/science/article/abs/pii/S0378427413014653

Accumulating evidence suggests that aminomethylphosphonic acid (AMPA), the primary metabolite of the herbicide glyphosate—a probable human carcinogen, may itself be carcinogenic. However, the relationship between urinary AMPA excretion and breast cancer risk in women is unknown. In this pilot study, we investigated the association between pre-diagnostic urinary AMPA excretion and breast cancer risk in a case-control study of 250 predominantly postmenopausal women: 124 cases and 126 healthy controls (individually matched on age, race/ethnicity, urine type, date of urine collection, and fasting status) nested within the Hawaii biospecimen subcohort of the Multiethnic Cohort. AMPA was detected in 90% of cases and 84% of controls. To our knowledge, this is the first study to prospectively examine associations between urinary AMPA excretion and breast cancer risk. Our preliminary findings suggest that AMPA exposure may be associated with increased breast cancer risk; however, these results require confirmation in a larger population to increase study power and permit careful examinations of race/ethnicity differences.

b) Mesnage, R., et al. 2021. Urinary excretion of herbicide co-formulants after oral exposure to Roundup MON 52276 in rats. Environmental Research. Online at https://www.sciencedirect.com/science/article/pii/S0013935121003972?via%3Dihub

Unknown risks of co-formulants/ adjuvants/ additives to various roundup formula have not been properly explored. Most research is on glyphosate the active ingredient. However the risk of adjuvants is under explored and some of them indicate a risk of body accumulation of these compounds with unknown risk profiles.

3.5) Finally and perhaps most concerning is the identified risk **of hormone disruption in humans** by Roundup. This has numerous ramifications both for current and future generations.

a) Impacts of Roundup on hormone disruption in humans

Lesseur, C., et al. 2021. Maternal urinary levels of glyphosate during pregnancy and anogenital distance in newborns in a US multicenter pregnancy cohort. Environmental Pollution (280).

https://pubmed.ncbi.nlm.nih.gov/33812205/

Human exposure to glyphosate has become ubiquitous because of its increasing agricultural use. Recent studies suggest endocrine disrupting effects of glyphosate. Specifically, in our work in rodents, low-dose early-life exposure to Roundup® (glyphosate-based herbicide) lengthened anogenital distance (AGD) in male and female offspring. AGD is a marker of the prenatal hormone milieu in rodents and humans. The relationship between glyphosate exposure and AGD has not been studied in humans. We conducted a pilot study in 94 mother-infant pairs (45 female and 49 male) from The Infant Development and the Environment Study (TIDES). These preliminary findings partially reproduce our previous results in rodents and suggest that glyphosate is a sex-specific endocrine disruptor with androgenic effects in humans. Given the increasing glyphosate exposures in the US population, larger studies should evaluate potential developmental effects on endocrine and reproductive systems.

4. ALTERNATIVES TO MANAGE ROADSIDE / VERGE WEED GROWTH

4.1) Existing alternatives in use.

In the data sheets and material supplied to us from the City of Cape Town, as per the road verge spray program, we note that the alternative herbicides indicated (namely Simazine/Terbuthylazine) are also chemicals of concern in that they are noted endocrine/ hormone disruptors (see point 3.5.a above). A brief scan of the literature indicates a heightened risk of these to aquatic organisms, particularly to the females of such species because of this hormonal action[11]. Simazine is related to the herbicide Atrazine which is banned in many places around the world for precisely this reason. The negative impact of endocrine disruptors is well known and of increasing concern to natural scientists [12]. It appears that these herbcides are also relatively stable in the soil, indicating a long term risk of application to soil dwelling and contacting species[12].

4.2) Suggestions toward alternatives and less impactful ways to manage weeds in sensitive areas.

This all leaves the city with a conundrum; how to manage roadside and other weeds? It must be noted that roadside verges and near road traffic islands and intersection verges provide important habitat for numerous species of both flowering plants and insects[14]. They provide useful corridors for seed and insect dispersal[15] and as such should not be managed in a generalist manner, but with sensitivity to specific locations. The city is aware that there has been pressure for years to preserve the natural ecology of these spaces, particularly during flowering season. This pressure will continue and stands to increase in the face of ongoing species collapse, land use pressure and ecological erosion of biodiversity, along with greater sensitivity to these issues by residents. These pressures to maintain and enhance biodiversity are not limited to Cape Town[13] but are national and international in nature and there is a wealth of literature to support these initiatives. Eden Municipality provided a useful study to inform road verge management in the district.[14] South Australia, an area with similar climate to Cape Town, also has useful guidelines which preclude wholesale herbicide use[15].

We must also remark that we are not against using herbicides in certain extremely limited circumstances. However, these must be carefully selected and applied and should not be used where runoff will enter important wetlands, aquatic systems, or areas of important biodiversity. Using herbicides on invasive alien species removal programmes is generally of far lower impact as the use is targeted, selective and usually applied in such a way as to greatly limit spread and environmental contamination, through the use of spot applications and hand application of these chemicals, rather than through wholesale verge spray programmes. Verge spraying is currently undertaken in a

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[11] The effects of simazine, a chlorotriazine herbicide, on pubertal development in the female Wistar rat. https://www.sciencedirect.com/science/article/abs/pii/S0890623810000778 [12] Endocrine-disrupting chemicals and male reproductive health. https://onlinelibrary.wiley.com/doi/full/10.1002/rmb2.12326

[12] Persistence of Simazine and Terbuthylazine in a Semiarid Soil after Organic Amendment with Urban Sewage Sludge. https://pubs.acs.org/doi/10.1021/jf034435s [14] Ecosystem service provision by road verges. https://besjournals.onlinelibrary.wiley.com/doi/pdf/10.1111/1365-2664.13556 [15] Roles of roadside vegetation in insect conservation in Australia. https://onlinelibrary.wiley.com/doi/full/10.1111/aen.12511

[13] On the verge: a quiet roadside revolution is boosting wildflowers. https://www.theguardian.com/environment/2020/mar/14/on-the-verge-a-quiet-roadside-revolution-isboosting-wildflowers-aoe

[14] Road-verge Vegetation Management Guidelines for Eden District Municipality. tinyurl.com/7eph4fju

[15] Guidelines for the Management of Roadside Vegetation – South Australia. tinyurl.com/2z475dea [19] Environmentally friendly weed control. https://southperth.wa.gov.au/about-us/news-and-publications/news-and-public-notices/news-detail/2017/01/17/environmentally-friendly-weed-control [20] https://www.facebook.com/noordhoek.ontheverge

generalist one-size-fits-all programme with little or no allowance for local requirements and ecological threats.

There are other ways to manage the challenges of managing verges which include:

- Use of strimmers and manual weed removal – while higher cost it does increase the opportunity for employment and may be linked to EPWP type programmes such as working for water, working for fire, etc. The downside is that mechanical removal needs to be managed with care not to destroy important patches of roadside vegetation.
- The use of non-toxic herbicides such as ascetic acid (vinegar of various concentrations, (usually ~15%) has been successfully used,
- Perth in Western Australia uses a steam weeder[19] to manage verges because of similar threats and pressures as outlined above,
- Co-operation with and support of local organisations that manage verge areas such as On the Verge in Noordhoek[20] and Eden project in the South Peninsula area provide useful alternatives for the city to pursue.

Below is additional information added in July 2022 which includes brief examination of two additional chemicals: Esplanade (active ingredient indaziflam), and Triazine pre-emergence herbicides (active ingredient Simazine/ terbuthylazine)

Note on use of Triazine pre-emergence herbicides to supplement and or replace Roundup/glyphosate based herbicides.

According to documents received via the City of Cape Town the current contractor (Henchem) uses Simazine/Terbuthylazine. Our research shows that this chemical holds significant risk to aquatic ecosystems, both due to its persistence and toxicity to organisms in the aquatic biome. Despite the contractors claim that the chemical breaks down within three months, independent published science shows it has a half life (where half of the chemical remains active) of over 6 months. This persistence is of deep concern and both this chemical and its related azine group have been withdrawn from use or banned from being used in ecosensitive areas. It is our opinion that this chemical should not be used at all. Further, the risk of tank mixtures of both this and glyphosate raises deep concerns as no literature is available to evaluate the risks of such mixing of chemicals. It has been repeatedly noted in the published literature that such mixing may create synergistic effects where the impacts of the chemicals may be worsened.

We provide a few relevant studies to underline our concerns.

Navarro S, Vela N, Giménez MJ, Navarro G. Effect of temperature on the disappearance of four triazine herbicides in environmental waters. Chemosphere. 2004 Oct;57(1):51-9. doi: 10.1016/j.chemosphere.2004.05.016. PMID: 15288199.

The influence of temperature on the disappearance of four s-triazine herbicides, terbuthylazine, simazine, atrazine and prometryn was studied in sea, river and groundwaters spiked with approx. 5 mg l(-1) of each during long-term laboratory incubation. Residues were analyzed by GC-NPD and confirmed by GC-MSD. No clean-up was necessary and a micro on-line method for the determination of herbicide residues was used. The results showed that temperature had little effect on the

behaviour of the four herbicides in river and seawaters but strongly affected their behaviour in groundwater. Simazine was the most readily affected compound in sea, river and groundwaters, while terbuthylazine and atrazine were the most persistent in all cases, especially in riverwater. Half-lives ranged from 41 days (constant rate = 0.017 days(-1)) to 196 days (constant rate = 0.003 days(-1)) for simazine (40 degrees C) and terbuthylazine (20 degrees C), respectively, in riverwater. Only for terbuthylazine in riverwater was the remaining percentage at the end of the experiment higher than 50% (58%, 3.21 mg l(-1)). In the other cases, the remaining percentage varied from 4% (0.20 mg l(-1), 40 degrees C) to 43% (2.25 mg l(-1), 20 degrees C) for simazine and terbuthylazine, respectively, in groundwater.

Želježić D, Žunec S, Bjeliš M, Benković V, Mladinić M, Lovaković Tariba B, Pavičić I, Marjanović Čermak AM, Kašuba V, Milić M, Pizent A, Lucić Vrdoljak A, Kopjar N. Effects of the chloro-s-triazine herbicide terbuthylazine on DNA integrity in human and mouse cells. Environ Sci Pollut Res Int. 2018 Jul;25(19):19065-19081. doi: 10.1007/s11356-018-2046-7. Epub 2018 May 2. PMID: 29721798.

Terbuthylazine belongs to the chloro-s-triazine group of herbicides and acts primarily as a photosynthesis inhibitor. The mechanisms of action related to its exposure, relevant both in animals and humans, are still insufficiently investigated. This comprehensive study focused on the outcomes of terbuthylazine exposure at cell level in vitro, and a mice model in vivo. Experiments in vitro were conducted on whole human peripheral blood, isolated lymphocytes, and HepG2 cells exposed for 4 h to terbuthylazine at 8.00, 0.80, and 0.58 ng/mL, which is comparable with current reference values set by the European Commission in 2011. Terbuthylazine cytotoxicity was evaluated using dual fluorescent staining with ethidium bromide and acridine orange on lymphocytes, and CCK-8 colorimetric assay on HepG2 cells. The levels of DNA damage were measured using alkaline and hOGG1-modified comet assays. The potency of terbuthlyazine regarding induction of oxidative stress in vitro was studied using a battery of standard oxidative stress biomarkers. The in vivo experiment was conducted on Swiss albino mice exposed to terbuthlyazine in the form of an active substance and its formulated commercial product Radazin TZ-50 at a daily dose of 0.0035 mg/kg bw for 14 days. Following exposure, the DNA damage levels in leukocytes, bone marrow, liver, and kidney cells of the treated mice were measured using an alkaline comet assay. In vitro results suggested low terbuthylazine cytotoxicity in non-target cells. The highest tested concentration (8.00 ng/mL) reduced lymphocyte viability by 15%, mostly due to apoptosis, while cytotoxic effects in HepG2 cells at the same concentration were negligible. Acute in vitro exposure of human lymphocytes and HepG2 cells to terbuthylazine resulted in low-level DNA instability, as detected by the alkaline comet assay. Further characterization of the mechanisms behind the DNA damage obtained using the hOGG1-modified comet assay indicated that oxidative DNA damage did not prevail in the overall damage. This was further confirmed by the measured levels of oxidative stress markers, which were mostly comparable to control. Results obtained in mice indicate that both the active substance and formulated commercial product of terbuthylazine produced DNA instability in all of the studied cell types. We found that DNA in liver and kidney cells was more prone to direct toxic effects of the parent compound and its metabolites than DNA in leukocytes and bone marrow cells. The overall findings suggest the formation of reactive terbuthylazine metabolites capable of inducing DNA cross-links, which hinder DNA migration. These effects were most pronounced in liver cells in vivo and HepG2 cells in vitro. To provide a more accurate explanation of the observed effects, additional research is needed. Nevertheless, the present study provides evidence that terbuthylazine at concentrations comparable with current reference values possesses toxicological risk because it

caused low-level DNA instability, both at cellular and animal organism level, which should be further established in forthcoming studies.

Goessens T, De Baere S, Deknock A, et al. Agricultural contaminants in amphibian breeding ponds: Occurrence, risk and correlation with agricultural land use. The Science of the Total Environment. 2022 Feb;806(Pt 2):150661. DOI: 10.1016/j.scitotenv.2021.150661. PMID: 34597541.

Anthropogenic pressure such as agricultural pollution globally affects amphibian populations. In this study, a total of 178 different compounds from five agrochemical groups (i.e. antimicrobial drugs residues (ADRs), coccidiostats and anthelmintics, heavy metals, mycotoxins and pesticides) were determined monthly, from March until June 2019 in 26 amphibian breeding ponds in Flanders, Belgium. Furthermore, a possible correlation between the number and concentration of selected contaminants that were found and the percentage of arable land within a 200 m radius was studied. Within each group, the highest detected concentrations were obtained for 4-epioxytetracycline (0.422 µg L^{-1}), levamisole (0.550 µg L^{-1}), zinc (333.1 µg L^{-1}), 3-acetyldeoxynivalenol (0.013 µg L^{-1}), and terbuthylazine (38.7 µg L^{-1}), respectively, with detection frequencies ranging from 1 (i.e. 3-acetyldeoxynivalenol) to 26 (i.e. zinc) out of 26 ponds. Based on reported acute and chronic ecotoxicological endpoints, detected concentrations of bifenthrin, cadmium, copper, cypermethrin, hexachlorobenzene, mercury, terbuthylazine, and zinc pose a substantial ecological risk to aquatic invertebrates such as Daphnia magna and Ceriodaphnia dubia, which both play a role in the food web and potentially in amphibian disease dynamics. Additionally, the detected concentrations of copper were high enough to exert chronic toxicity in the gray treefrog (Hyla versicolor). The number of detected compounds per pond ranged between 0 and 5 (ADRs), 0 - 2 (coccidiostats and anthelmintics), 1 - 7 (heavy metals), 0 - 4 (mycotoxins), and 0 - 12 (pesticides) across the four months. Furthermore, no significant correlation was demonstrated between the number of detected compounds per pond, as well as the detected concentrations of 4-epioxytetracycline, levamisole, copper, zinc, enniatin B and terbuthylazine, and the percentage of arable land within a 200 m radius. For heavy metals and pesticides, the number of compounds per pond varied significantly between months. Conclusively, amphibian breeding ponds in Flanders were frequently contaminated with agrochemicals, yielding concentrations up to the high µg per liter level, regardless of the percentage surrounding arable land, however showing temporal variation for heavy metals and pesticides. This research also identifies potential hazardous substances which may be added to the European watch list (CD 2018/408/EC) in the future.

South African data sheet on terbuthylazine.

https://www.farmag.co.za/wp-content/uploads/2018/09/ https://www.farmag.co.za/wp-content/uploads/2018/09/Terbuthylazine-500-SC-MSDS-1.pdf -500-SC-MSDS-1.pdf

Environmental hazard : Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

This is of extreme concern given that Henchem indicates that this product must be used when rainfall is imminent so that it can leach into the soil. The obvious issue is application during this time greatly increases the risk of runoff into the aquatic environment. Accordingly we cannot support the use of this chemical in the Cape Town Metropole.

Note on use of Esplanade (active ingredient indaziflam) as a replacement for Roundup

We have been notified that the city is looking into the use of Esplanade as a replacement/ supplement for Roundup in Cape Town and believe that this may be part of the current tender process currently underway.

Indaziflam is a fairly recent introduction into the herbicide panoply, gaining registration in 2010 in the USA, whereas glyphosate has been used for over 25 years. As a result there is far less published literature on Indaziflam. However we note with concern that even given a shortage of independent post release review, several studies show serious concerns with this chemical which may have a more serious impact on some aquatic species and also possibly on our botanical biodiversity. We include some recently published peer reviewed studies on the impacts of this chemical below.

The first of our concerns lies around the stability of this chemical, which means it has a high likelihood of persistence, affecting both non target plant species for prolonged times and also as to impacts on other biota such as fish, shellfish and reptiles.

Eckelmann, D., Augustin, T. and Leake. C. 2020. Isomeric stability of indaziflam and major degradation products in the environment. Science of The Total Environment, 737.

Understanding the isomeric behavior of active ingredients in the soil and water environment is the first and a major part of deriving an exposure assessment. Whilst a variety of approaches have been taken previously, with the new regulatory framework for the risk assessment of isomeric plant protection compounds recently published by EFSA, (European Food Safety Authority) there will in future be a more consistent approach which has been taken here. For indaziflam (IAF), the alkylazine, cross spectrum residual herbicide which has a cellulose biosynthesis inhibition mode of action, there was no published data on the isomeric degradation behavior in soil and water. The results of measuring the isomeric stability of [^{14}C]-radiolabeled 437-IAF, the major stereoisomer of indaziflam (AE 1170437, [*1R,2S,6R*] configuration) during its degradation in an aerobic soil metabolism study with four EU soils, an aerobic aquatic metabolism study with two natural water/sediment test systems, as well as an aqueous photolysis study are reported. To sum up, it was shown that in the different environmental conditions under abiotic as well as biotic degradation processes, indaziflam was not subject to isomeric interconversion to diastereoisomers 435-IAF (*RRR*), 438-IAF (*RSS*), or 439-IAF (*SSR*). Thus, all three chiral centers of indaziflam can be considered isomerically stable. In addition, no isomeric interconversion was observed at the 1-fluoroethyl position for the major degradation products IAF-indanone and IAF-carboxylic acid to the *RSS*-configuration as well as IAF-diaminotriazine from the *R*- to the *S*-configuration.

This is of concern given that this chemical has been shown to be of concern in its impacts on non-target species. Given the lack of study of the impacts of this chemical on our native biodiversity the study below, in relatively low plant biodiversity areas, raises serious concern.

Jordan Meyer-Morey, J., Lavin, M., Mangold, J., Zabinski, C., Rew, L.J. 2021. Indaziflam controls nonnative *Alyssum* spp. but negatively affects native forbs in sagebrush steppe. Invasive Plant Science and Management, 14(4):253-261.

Nonnative plant invasions can have devastating effects on native plant communities; conversely, management efforts can have nontarget and deleterious impacts on desirable plants. In the arid sagebrush steppe rangelands of the western United States, nonnative winter annual species affect forage production and biodiversity. One method proposed to control these species is to suppress the soil seedbank using the preemergent herbicide indaziflam. Our goal was to evaluate the efficacy of

indaziflam to control nonnative annual mustards (*Alyssum* spp.) and to understand potential nontarget effects of management on the diverse mountain sagebrush steppe plant communities within Yellowstone National Park. Six sites were established along an elevation gradient (1,615 to 2,437 m), each with high and low *Alyssum* spp. infestations. We applied 63g ai ha^{-1} of indaziflam in late summer of 2018 and evaluated plant community cover in situ for 2 yr after treatment and emergence of forb species from the soil seedbank ex situ. Indaziflam was highly effective at controlling emergence of *Alyssum* spp. for 2 yr. Richness and Shannon's diversity of the nontarget plant community were significantly lower in sprayed plots than in the control, and both decreased along the elevation gradient. These reductions were due to a decrease in perennial forbs and native annual forbs in the sprayed plots; perennial graminoids were not affected. Overall, the aboveground and seedbank community composition was negatively impacted by indaziflam, and these effects were strongest for the native annual forbs that rely on annual regeneration from the seedbank. The effects of this herbicide to the nontarget community should be evaluated beyond the length of our study time; however, we conclude that indaziflam should likely be reserved for use in areas that are severely invaded and have seedbanks that are composed of nondesirable species rather than diverse, native mountain sagebrush communities.

This chemical has also been shown to impact aquatic species, such as marine bivalves, an issue which should be of concern in particular to Cape Town given the high likelihood of runoff from roadside spraying into stormwater systems and then to the sea. This is especially so given the indications of the stability of this chemical as shown by Ecklemann et al above. This is especially concerning given the high levels of marine biodiversity in the discussion area of the Cape Peninsula.

Alexandra G.Tissot, A. G., Grinek, E. F., Thompson, A. W., Hladik, M. L., Scully-Englemeir, K. 2022. Silence of the Clams: Forestry registered pesticides as multiple stressors on soft-shell clams. Science of The Total Environment, 819.

Contaminants are ubiquitous in the environment, often reaching aquatic systems. Combinations of forestry use pesticides have been detected in both water and aquatic organism tissue samples in coastal systems. Yet, most toxicological studies focus on the effects of these pesticides individually, at high doses, and over acute time periods, which, while key for establishing toxicity and safe limits, are rarely environmentally realistic. We examined chronic (90 days) exposure by the soft-shell clam, *Mya arenaria*, to environmentally relevant concentrations of four pesticides registered for use in forestry (atrazine, 5 μg/L; hexazinone, 0.3 μg/L; indaziflam, 5 μg/L; and bifenthrin, 1.5 μg/g organic carbon (OC)). Pesticides were tested individually and in combination, except bifenthrin, which was tested only in combination with the other three. We measured shell growth and condition index every 30 days, as well as feeding rates, mortality, and chemical concentrations in tissue from a subset of clams at the end of the experiment to measure contaminant uptake. Indaziflam caused a high mortality rate (max. 36%), followed by atrazine (max. 27%), both individually as well as in combination with other pesticides. Additionally, indaziflam concentrations in tissue (61.70–152.56 ng/g) were higher than those of atrazine (26.48–48.56 ng/g), despite equal dosing concentrations, indicating higher tissue accumulation. Furthermore, clams exposed to indaziflam and hexazinone experienced reduced condition index and clearance rates individually and in combination with other compounds; however, the two combined did not result in significant mortality. These two compounds, even at environmentally relevant concentrations, affected a non-target organism and, in the case of the herbicide indaziflam, accumulated in clam tissue and appeared more toxic than other tested pesticides. These findings underscore the need for more comprehensive studies combining multiple compounds at relevant concentrations to understand their impacts on aquatic ecosystems.

*****Given the above brief summaries of recent published science, we feel strongly that this chemical should not be used to either replace or as is general practice, to be mixed with Glyphosate based chemicals. Rather than improving and reducing the impacts, the use of this chemical stands to exacerbate the impact of herbicides to clear roadside verges. We cannot support the use of this chemical in any of the areas in Cape Town Metropole.**