Backgrounder
Summary of Ecotoxicological Risk Assessment for Roundup® Herbicide
February, 2005

In 2000, three internationally recognized experts in environmental toxicology published a peer-reviewed environmental safety evaluation of glyphosate and the original Roundup herbicide formulation[1] that has been used around the world for more than twenty years. The authors reviewed Monsanto studies that had been previously considered by regulatory authorities around the world[2]. In addition, they reviewed reports from regulatory and scientific institutions, as well as a wide array of studies conducted by independent researchers using information from the public literature. Over a two-year period, more than 250 documents were reviewed to evaluate the potential risk to wildlife (including mammals, birds, insects, soil invertebrates, microorganisms, fish, amphibians, and aquatic invertebrates) and non-target vegetation.

The article, "Ecotoxicological Risk Assessment for Roundup® Herbicide," by John P. Giesy, Stuart Dobson and Keith R. Solomon, was published in *Reviews of Environmental Contamination and Toxicology*, (2000) Volume 167, pages 35-120. The overall findings of this evaluation are described below.

Summary of Findings

The current state of knowledge on the ecological effects of Roundup® herbicide and its active ingredient, glyphosate, was reviewed. A comprehensive ecotoxicological risk assessment was conducted using a conservative hazard quotient method, in which a hazard quotient less than 1 indicates minimal risk of adverse effects. The no-effect-level for the most sensitive species was used as the toxicity endpoint in the assessment for aquatic and terrestrial organisms potentially exposed to Roundup or its components. Exposure levels were derived from environmental monitoring data or dissipation models. The predicted maximum acute and chronic hazard quotients were less than 1 for aquatic and terrestrial organisms following terrestrial Roundup uses, confirming that there is minimal risk of adverse effects. The acute assessment for honeybees also indicated minimal risk of adverse effects. Minimal risk of adverse effects was also indicated for beneficial arthropod populations in areas adjacent to treated areas. The authors concluded that expected vegetation change in treated areas can impact beneficial arthropod populations living there. The authors further concluded that Roundup use for aquatic habitat restoration can be conducted without unreasonable adverse effects on the environment, provided that factors such as application rate, depth of water, vegetation density, and overall rehabilitation goals are considered. This assessment indicates that application of Roundup in terrestrial and aquatic sites, including agriculture, forestry, residential, rights-of-way and habitat restoration, poses minimal risk to non-target species.

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[1] In this Backgrounder, "Roundup" refers to the original Roundup agricultural herbicide (MON 2139), which contained the active ingredient glyphosate (as the isopropylamine salt), water and a surfactant (polyoxyethylenealkylamine or POEA).

[2] *"Formulations of glyphosate, including Roundup® Herbicide, have been extensively investigated for their potential to produce adverse effects in non-target organisms. Governmental regulatory agencies, international organizations, and others have reviewed and assessed the available scientific data for glyphosate formulations, and independently judged their safety. Conclusions from three major organizations are publicly available and indicate Roundup can be used with minimal risk to the environment (Agriculture Canada 1991; United States Environmental Protection Agency (USEPA) 1993a; World Health Organization (WHO) 1994)." (p. 36)*

Key Findings:

- **Glyphosate dissipates from soil and water.** Glyphosate has been shown to degrade in soil to naturally occurring products. "*Field studies indicate that glyphosate typically dissipates rapidly from both simple ecosystems, such as agricultural, and more complex ecosystems, such as forestry…" (p. 51)* Glyphosate has been shown to degrade in terrestrial and aquatic systems, predominantly via microbial processes. Field studies conducted in agricultural and forest soils (13 studies, 5 countries, 47 different sites) indicate an average half-life of 32 days. *"Both field and laboratory studies have reported microbial degradation of glyphosate to AMPA and CO_2 in aquatic environments and rapid dissipation from both flowing and standing surface waters."* (p.53). "*The results of field studies indicate that 50% of the concentration of glyphosate initially found in water dissipates within time periods ranging from a few days to 2 weeks."* (p. 53)

- **Contact with soil reduces bioavailability.** *"Once glyphosate enters the soil, it is essentially unavailable to plants due to its very high affinity for soil."* (p. 43)

- **Minimal leaching and runoff.** *"Although glyphosate is very soluble in water, its strong sorption to soils limits mobility."* (p. 48) *"Glyphosate is unlikely to leach into ground water or runoff significantly into surface water following application.* (p. 49) *"POEA* [the surfactant in Roundup] *strongly adsorbs to soil … thus, the mobility of POEA in soil is expected to be less than 2%."* (p. 50)

- **Spray drift is well characterized.** *"Glyphosate has no significant vapor pressure; therefore, loss of glyphosate to the atmosphere via vaporization from treated surfaces is negligible."* (p.47) Spray drift can occur into non-target areas, but the drift levels have been well characterized. No long-term adverse effects are predicted for animals or soil microbes as a result of aerial spray drift. Non-target plants directly adjacent to the treated fields may be affected if present at a sensitive life stage; however, no effects are predicted at distances greater than 4 m. *"Aerial applications can result in increased drift relative to ground applications, but recent technological advances have significantly reduced aerial spray drift."* (p. 103)

- **No significant bioaccumulation in animals.** *"Neither glyphosate nor Roundup would be expected to bioaccumulate."* (p. 57) *"…glyphosate does not bioconcentrate in fish or other animals."* (p. 103).

- **Terrestrial applications pose little risk to:**
  <u>Aquatic organisms (including amphibians)</u> – *"[Hazard Quotient] values are considerably less than 1.0, indicating that Roundup poses minimal risk to aquatic organisms following terrestrial use."* (p. 89) *"…minimal risk from the application of Roundup would be expected for sediment dwelling organisms."* (p. 89)
  <u>Soil organisms</u> – *"…minimal acute hazard is predicted for populations of soil organisms."* (p. 94) *"The weight of evidence for effects of Roundup on soil microorganisms indicates that adverse effects would be unlikely as a result of application at normal field rates … Earthworms are predicted to be at minimal risk from the use of Roundup or glyphosate."* (p. 95-96)
  <u>Beneficial arthropods (insects)</u> – *"…the literature supports the conclusion that non-target arthropods are at minimal risk from glyphosate and its formulations."* (p. 99) Most effects result from habitat change because of the decision to remove vegetation. *"Several studies have found that the application of glyphosate can increase populations of*

beneficial insects … No effects on the number of common butterfly species were observed when glyphosate was used to control trees, shrubs and blackberry in wire zones; but numbers of individuals did increase." (p. 99) *"Honeybees are not affected by glyphosate formulations, either by ingestion or direct overspray, at maximum use rates."* (p. 103)
Birds – *"Several comprehensive field studies have observed birds in forest plots treated with Roundup … In no case was there evidence of direct toxicity of Roundup or glyphosate to birds."* (p. 97)
Mammals – *"It has been concluded that there is minimal risk to small mammals from the application of glyphosate products and that the effects observed in the field studies are a result of changes in habitat."* (p. 98)

- **Aquatic applications help restore wildlife habitat.** *"Glyphosate has been used extensively to control aquatic weeds and restore ecosystems affected by introductions of exotic weeds."* (p. 101) The objective of an aquatic herbicide application is to remove weed species. *"It is inevitable that some short-term population level effects on plants and associated animals should occur in the pursuit of a long-term goal characteristic of restoration/rehabilitation projects."* (p. 100) Roundup[3] can be safely used for aquatic habitat restoration projects with knowledge of the water depth, vegetation density, and overall rehabilitation goal.

REFERENCES IN ITALICS THROUGHOUT THIS DOCUMENT REFER TO STATEMENTS OR CONCEPTS EXPRESSED BY THE AUTHORS OF "ECOTOXICOLOGICAL RISK ASSESSMENT FOR ROUNDUP® HERBICIDE."

BIOGRAPHICAL DATA:

John P. Giesy, Ph.D., is Distinguished Professor of Zoology at Michigan State University in East Lansing, Michigan, where he is also a Professor of Veterinary Medicine and on the faculties of the Center for Integrative Toxicology and a member of the National Food Safety and Toxicology Center. Prof. Giesy is a world leading ecotoxicologist with interests in many aspects of ecotoxicology, including both the fates and effects of potentially toxic compounds and elements, particularly in the area of ecological risk assessment. He has conducted research into the movement, bioaccumulation and effects of toxic substances at different levels of biological organization, ranging from biochemical to ecosystem. Currently, Prof. Giesy and his research group are actively studying the toxicity and reproductive effects of organic compounds, with special emphasis on herbicides, chlorinated dioxins and perfluorinated compounds. Prof. Giesy is an expert in ecological risk assessments of both industrial and agricultural chemicals. He has authored several books and more than 150 peer-reviewed publications, and has presented hundreds of lectures worldwide. He is the recipient of the Sigma Xi Meritorious Research Award, the CIBA-GEIGY Agricultural Recognition Award, and the Willard F. Shepard Award from the Michigan Water Pollution Control Association. Prof. Giesy is a Fellow of the Cooperative Institute for Limnology and Ecosystems Research, and is currently a member of the Executive Committee of the Board of Scientific Counselors (BOSC) of the US EPA's Office of Research and Development.

Stuart Dobson, Ph.D., is the head of the Research Station at Monks Wood, Centre for Ecology and Hydrology, Cambridgeshire, United Kingdom. He is a member of the Advisory Committee on

[3] Only certain Roundup-branded formulations in certain world areas are labeled for aquatic use. Other glyphosate herbicide products are labeled for aquatic use in other world areas. Use of a product inconsistent with its label is a violation of law and is strictly prohibited.

Toxic Substances, Health and Safety Executive, the chairman of the Core Assessment Group (Environment) of the Joint Meeting on Pesticides (WHO/FAO) and an advisor representing the United Kingdom Department of the Environment on the Advisory Committee on Pesticides for licensing new products. He is also a consultant to the International Programme on Chemical Safety (World Health Organization) and a consultant to the United Kingdom Department of Environment on toxic chemical effects on wildlife.

Keith R. Solomon, PhD., is Director for the Center of Toxicology, University of Guelph and is also a Professor in the Department of Environmental Biology. Professor Solomon teaches courses in toxicology and pesticides at the University of Guelph. He directs an active program of research into the fate and effects of pesticides in the environment as well as exposure of humans to pesticides. He currently serves on several advisory committees on matters related to environmental toxicology and pesticides in the USA and Canada and is an active member of the Society of Environmental Toxicology and Chemistry, the Entomological Society of American and the Toxicology Forum. He is the recipient of the 1993 Society for Environmental Toxicology and Chemistry-ABC Laboratories award for Environmental Education. He is a Graduate of Rhodes University in Chemistry and Zoology and holds M. Sc. degrees from Rhodes University and the University of Illinois as well as a Ph.D. from the University of Illinois. He has more than 25 years of experience in research and teaching in pesticide science and environmental toxicology and has contributed to more than 100 scientific publications in the fields of pesticides and environmental toxicology.

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