UF IFAS Extension UNIVERSITY of FLORIDA

SS-AGR-104

Safe Use of Glyphosate-Containing Products in Aquatic and Upland Natural Areas[1]

K. A. Langeland and Lyn A. Gettys[2]

Land and water managers who apply herbicides to control invasive plant species and other nuisance vegetation strive to minimize environmental impacts as a matter of policy and daily operations. Therefore, it is not surprising concern and questions have arisen after a number of publications in the mid-2000s implicated the use of glyphosate-containing herbicides in the global decline of amphibians (Relyea 2005a, 2005b, 2005c). The purpose of this article is to put these publications in perspective relative to weed management in aquatic and terrestrial natural areas and to explain why land managers should continue to use glyphosate-containing products in these systems without fear of causing unreasonable adverse environmental impacts.

Relyea (2005a, 2005b, 2005c) conducted studies in "mesocosms" (tanks) to test the toxicity of a glyphosate-containing herbicide on amphibian species. Roundup Weed and Grass Killer, which contains 25.2% glyphosate [2.5 lbs. glyphosate active ingredient (a.i.) per gallon] and an unknown amount of polyethoxylated tallowamine (POEA) surfactant, was applied to water in test tanks. This product is **NOT** registered for application to aquatic sites. In one of the studies, tests were conducted for 16 days and the treatment solution (water and initial herbicide concentration) was renewed every four days (Relyea 2005a). Relyea concluded that "Roundup with the POEA surfactant has the potential to play a major role in amphibian declines" because application of the equivalent of 3.7 ppm a.i. glyphosate killed 90 to 100% of tadpoles of all six amphibian species tested (Relyea 2005a). This concentration represents the maximum that would occur if Roundup were applied as a broadcast treatment of the highest label rate to water 15 cm (5.9 inches) deep without intercepting vegetation, which is unlikely to occur under normal field conditions. In another study (Relyea 2005b), an application of the maximum rate of a glyphosate-containing product was applied to three species of juvenile terrestrial amphibians to simulate a direct application to an agricultural field with no intercepting vegetation. Across all species, only 21% of the glyphosate-treated amphibians survived after one day, and Relyea concluded that "applying Roundup formulations containing the POEA surfactant to amphibian habitats has the potential to cause substantial mortality to many amphibian species" (Relyea 2005b). In 2012, Reylea reported the effects of Roundup Original MAX, a glyphosate-containing herbicide, on tadpoles (Reylea 2012). However, Roundup Original MAX contains a proprietary surfactant and is not registered for aquatic applications.

Table 1 lists the wide range of toxicities to different forms of glyphosate and glyphosate-containing products. Roundup is 10 to 100 times more toxic to indicator species

1. This document is SS-AGR-104, one of a series of the Agronomy Department, Center for Aquatic and Invasive Plants, UF/IFAS Extension. Original publication date February 2006. Revised June 2015. Visit the EDIS website at http://edis.ifas.ufl.edu.

2. Kenneth A. Langeland, professor emeritus; and Lyn A. Gettys, assistant professor, Agronomy Department, Fort Lauderdale Research and Education Center, Aquatic Plant Science Lab; UF/IFAS Extension, Gainesville, FL 32611.

than either the parent glyphosate acid or Rodeo, which contains the isopropylamine salt of glyphosate. POEA, the surfactant added to the original Roundup, was the most toxic surfactant of 19 tested on bluegill sunfish (Haller and Stocker 2003). Several studies have reported toxicity levels of glyphosate products to amphibian species (Edgington et al. 2004, Howe et al. 2004, Mann and Bidwell 1999, Wojtaszek et al. 2004, Perkins et al. 2000). The toxicity of Roundup to aquatic organisms due to the POEA surfactant was known by Monsanto (the registrant of Roundup) when Roundup was originally labeled in 1978, and these data were provided to the Environmental Protection Agency (EPA). This is why the Roundup formulation that contains POEA was not registered for aquatic uses; in fact, none of the many glyphosate-containing products currently registered for aquatic use contain POEA. Most glyphosate-containing products that are registered for aquatic use are manufactured without surfactant. These formulations allow applicators to assess their needs based on the target weeds, application site, and other factors and select a surfactant that has low toxicity to aquatic organisms and is labeled specifically for aquatic use. While the exact composition of commercial surfactants is proprietary information, these products are regulated and only contain ingredients that are approved by the EPA or the Food and Drug Administration.

Relyea's studies are not relevant when applying glyphosate-containing herbicides that do not contain POEA. The assumptions of Relyea's experiments exaggerate the potential impact of glyphosate-containing products used to control invasive plants in upland natural areas and in wetlands. Because glyphosate-containing products that are labeled only for terrestrial application are not applied to aquatic sites, aquatic organisms only risk exposure from drift or from contact with temporary pockets of water; in both scenarios, concentration much lower than maximum application rates would occur. When spot treatments of herbicide using hand-held equipment are made, the applicator has direct control of where the spray solution is applied and little, if any, herbicide comes into contact with standing water. Likewise, direct application of spray solution to amphibians is unlikely. Broadcast application of glyphosate-containing products with POEA are rarely made to upland natural areas because of potential damage to non-target plant species, and if broadcast applications are made, vegetation is present that intercepts a majority of the spray solution. Exposure of test organisms for 16 days with solution renewal every four days is not consistent with realistic exposure under vegetation management practices. Under field conditions, active ingredients and adjuvants are broken down or sequestered through natural processes; therefore, renewal of test solution every four days is equivalent to performing four separate applications. Field studies to assess impacts under representative natural conditions, and monitoring studies conducted under conditions relevant to product use, indicate that glyphosate herbicides registered for terrestrial application are not likely to result in adverse effects to amphibians when used according to label directions (Wojtaszek et al. 2004, Thompson et al. 2004).

When applying glyphosate-containing products containing POEA to upland natural areas, there is a wide margin of safety to amphibians and other wildlife relative to toxic levels and realistic potential exposure levels. Applicators who apply glyphosate-containing products according to instructions on the herbicide label and on the surfactant label will have an acceptable margin of safety to wildlife. Land managers should continue to use glyphosate-containing products to protect managed habitats from weeds without concern for unreasonable adverse environmental impacts, as originally determined by regulatory agencies when these products were considered for registration. There is no evidence to support the conclusion that the appropriate use of glyphosate alone is responsible for global declines in amphibian populations.

Literature Cited

Edgington, A. N., P.M. Sheridan, G. R. Stephenson, D. G. Thompson and H. J. Boermans. 2004. "Comparative effects of pH and Vision® herbicide on two life stages of four anuran amphibian species." *Environ. Toxicol. Chem.* 23: 815–822.

Haller, W. T., and R. K. Stocker. 2003. "Toxicity of 19 adjuvants to juvenile *Lepomis macrochirus* (bluegill sunfish)." *Environ. Toxicol. Chem.* 22: 615–619.

Howe, C. M., M. Berrill, B. D. Pauli, C. C. Helbing, K. Werry, and N. Veldhoen. 2004. "Toxicity of glyphosate-based pesticides to four North American frog species." *Environ. Toxicol. Chem.* 23: 1928–1938.

Mann, R. M., and J. R. Bidwell. 1999. "The toxicity of glyphosate formulations to four species of southwestern Australian frogs." *Arch. Environ. Contam. Toxicol.* 36: 193–199.

Perkins, P. J., H. J. Boemans, and G. T. Stephenson. 2000. "Toxicity of glyphosate and triclopyr using the frog embryo

teratogenesis assay—Xenopus." *Environ. Toxicol. Chem.* 19: 940–945.

Relyea, R. A. 2005a. "The lethal impacts of Roundup and predatory stress on six species of North American tadpoles." *Arch. Environ. Contam. Toxicol.* 48: 351–357.

Relyea, R. A. 2005b. "The lethal impact of Roundup on aquatic and terrestrial amphibians." *Ecological Applications* 15: 1118–1124.

Relyea, R. A. 2005c. "The impact of insecticides, and herbicides on the biodiversity and productivity of aquatic communities." *Ecological Applications* 15: 618–627.

Reylea, R. 2012. "New effects of Roundup on amphibians: Predators reduce herbicide mortality; herbicides induce antipredator morphology." *Ecological Applications* 22: 634–647.

Thompson, D. G., B. F. Wojtaszek, B. Staznik, D. T. Chartrand, and G. R. Stephenson, 2004. "Chemical and biomonitoring to assess potential acute effects of Vision® Herbicide on native amphibian larvae in forest wetlands." *Environ. Toxicol. Chem.* 23: 843–849.

Vencill, W. K. ed. 2002. *Herbicide Handbook.* Lawrence, KS: Weed Science Society of America.

Wojtaszek, B. F., B. Staznik, D. T. Chartrand, G. R. Stephenson, and D. G. Thompson. 2004. "Effects of Vision herbicide on mortality, avoidance response, and growth of amphibian larvae in two forest wetlands." *Environ. Toxicol. Chem.* 23: 832–842.

Table 1. Toxicity of glyphosate and glyphosate-containing herbicides to aquatic organisms when applied in different forms (Vencill 2002; Touchdown Pro data provided by Syngenta Crop Protection, Inc.).

Toxicity	Glyphosate acid	Touchdown Pro	Rodeo	Roundup
	mg/L			
Daphnia 48 hr LC50	780	160	930	5.3-37
Bluegill sunfish 96 hr LC50	120	>180	>1000	5.8-14
Rainbow trout 96 hr LC50	86	180	>1000	8.2-26