THE EARTH IS NOT ROUNDUP READY

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Pesticides, as a consequence of the inherent toxicity of constituent chemicals to the cellular functions of nearly all life forms, their potential to enhance toxicity of other pesticides, and their persistence in the environment, are contributing to the collapse of entire ecosystems. Each year 4.6 million tons of pesticides are sprayed or otherwise applied worldwide. The most heavily used pesticides, including glyphosate (an organophosphate herbicide), Atrazine (a herbicide in the triazine class), Chlorothalonil (a nitrile fungicide consisting of 2 cyanide molecules attached to a hexachlorobenzene ring), neonicotinoid insecticides (synthetic nicotine compounds), 2,4-D (an organochlorine herbicide), along with their metabolites, can work synergistically to harm non-target organisms at locations far removed from sites of application. For example, the toxicity of glyphosate, Atrazine and their two primary metabolites was shown to be synergistic when combined and toxicity levels were further enhanced by exposure to sunlight (A. Roustan, et. al., 2014, Genotoxicity of mixtures of glyphosate and atrazine and their environmental transformation products before and after photoactivation, http://dx.doi.org/10.1016/j.chemosphere.2014.02.079). Pesticides are typically designed to kill the target organisms more quickly or specifically than other organisms. Because all non-bacterial organisms (i.e., whose cells have nuclei) have the same basic biochemical and physiological pathways, a chemical that is particularly toxic to the target organisms cannot avoid being toxic to some degree to most other living organisms. For larger organisms, including humans, harmful effects have been shown by thousands of studies. Moreover, differences among both microorganisms and larger organisms in susceptibility to toxicity of different chemicals, profoundly disrupts relationships among those organisms, usually with serious, unintended consequences.

The following list of contributions to global ecosystem collapse and consequent Global Climate Change, which has been compiled by the author in consultation with Donald Huber, Stephanie Seneff, Anthony Samsel, Pamela Hallock and Tony Tweedale, is meant to initiate a discussion of the connections between the excessive use of one herbicide, glyphosate (Roundup), working synergistically with other widely used pesticides, and the documented global decline in rates of carbon dioxide (CO_2) removal from the atmosphere by plant life. Moreover, the consequences of glyphosate toxicity can increase the occurrence and intensity of wildfires, resulting in accelerated release of greenhouse gasses. **We contend that the resultant simultaneous increase in release of greenhouse gasses and decrease in the rate of carbon dioxide removal throughout the Earth's ecosystems contributes to the greenhouse effect and thus to the overall warming of the oceans and the Earth's climate.**

Most human activities contribute to Global Climate Change in some way. Burning of fossil fuels is adding CO_2 to the atmosphere at rates that are hundreds of times faster than annual rates of removal of CO_2 by natural processes, which include photosynthesis by plants ranging from the tiniest phytoplankton to the largest trees, as well as the breakdown of rocks to soil. At the same time, human activities have dramatically reduced the rates of uptake of CO_2 by natural processes. A few examples include deforestation for lumber and to clear land for agriculture; agricultural

practices that have destroyed formerly deep, rich organic soils; filling of wetlands, which are among the major repositories for organic carbon; development of coastlines; even buildings and pavement which reduce the land area available for plants to live and photosynthesize. These are all major constituents of the effects on the Earth's ecosystems referred to as Global Climate Change. Obviously, if these factors are not drastically mitigated, there will be severe consequences to the earth's ecosystems and to human civilizations planet-wide.

Unfortunately, the roles of glyphosate (Roundup) and other pesticides in accelerating Global Climate Change are seldom considered. To begin to understand how pesticides are contributing, one must think about how the chemicals work. Dr. Donald Huber has described the primary mode of action of glyphosate: "chelating (binding) manganese, a crucial cofactor in the biosynthesis of the aromatic amino acids, phenylalanine, tryptophan and tyrosine, which are essential building blocks of proteins. Roundup also has a more general action in that it chelates the soluble ions of many other mineral nutrients including calcium, copper, iron, magnesium, nickel and zinc, which are essential cofactors in many specific biochemical reactions." Since there is 100 to 1,000 times more free glyphosate in the plants than unbound mineral ions (i.e., "trace nutrients"), the chelation reduces the availability of essential mineral nutrients, including calcium and magnesium which are essential to alular functions and especially to bone development, and iron, which is of course essential to produce photosynthetic pigments in plants (and red blood cells in animals). Glyphosate weakens plants by limiting the availability of those nutrients, thereby opening the door to infection by pathogens, which healthy versions of the plants would normally resist (Johal & Huber, 2009; Huber, 2010). The use of Roundup began in 1974 and increased significantly in 1994 as a result of the release of new genetically modified seeds for Roundup Ready crops. There was another significant increase in use of Roundup in 2006 and 2010 with the release of additional varieties of Roundup Ready seeds including Roundup Ready Alfalfa.

As a consequence of its nearly ubiquitous use in agriculture and landscaping, glyphosate, the primary active ingredient in Roundup, was found in 75% of air and surface water tested in the United States. Similarly, glyphosate was recently found in a preliminary study of human mother's milk in the United States at levels between 760 and 1600 times what Europe allows in human drinking water. (http://www.organicconsumers.org/articles/article_29697.cfm)

Glyphosate Testing Full Report: Findings in American Mothers' Breast Milk, Urine and Water. Conducted by Moms Across America and Sustainable Pulse, April 7, 2014, Zen Honeycutt, Moms Across America | Henry Rowlands, Sustainable Pulse, (Download pdf of report here http://wtfrly.com/2014/04/09/worlds-number-1-herbicide-discovered-in-u-s-mothers-breast-milk/#.U1V817SwVss)

Since glyphosate is prevalent in human milk, it is extremely likely to be in the milk of all other mammals; especially those that consume mainly plant material (i.e., herbivores such as livestock, and wildlife ranging from mice to moose). Mineral deficiencies in plants exposed to glyphosate can result in mineral deficiencies in the animals that eat them. Mineral deficiencies result in thyroid hormone disruption; synthetic thyroid hormone has been one of the most widely prescribed medicines in the US since the 1980s. Thyroid hormone disruption during fetal development can cause the variety of birth defects that are increasingly observed on mammals, birds and other vertebrate species throughout the United States and Canada. In one published report, birth defects were first observed on several wildlife species in young born in 1995 and increased in prevalence through 2001. The specific birth defects, which other studies have related to mineral deficiencies

and thyroid hormone disruption, appeared the summer following the simultaneous extensive increase in glyphosate application on the new Roundup Ready crops planted in 1994 and a huge increase in use of fungicides, especially Chlorothalonil, on potato blight in summer of 1994 (Hoy, et. al., 2011, *Observations of brachygnathia superior in wild ruminants in Western Montana, USA.,* Wildl. Biol. Pract., 2011 December 7(2): doi:10.2461/wbp.2011.7.13) (Hoy, J.A., Hoy, R.D., Seba, D. & Kerstetter, T.H. 2002. Genital abnormalities in white-tailed deer (*Odocoileus virginianus*) in west-central Montana: Pesticide exposure as a possible cause. J Environ Biol 23: 189-197. PMid:12602857).

The incidences of birth defects on examined species of wild and domestic ungulates increased each year through 2001, and then decreased in prevalence from 2002 through 2006. Following the 2006 release of additional Roundup Ready crops, including Roundup Ready Alfalfa, the incidences of birth defects on mammals and birds abruptly increased in summer of 2007. Some malformations, such as underbite and heart defects, more than doubled in prevalence on white-tailed deer fawns and other examined ungulates. Interestingly, while the use of Chlorothalonil decreased significantly in 2001 and there was no significant increase in its use in 2006. The use of neonicotinoids began in the 1990s and increased in 2006.

Another impact on plants and photosynthesis is without adequate pollination, the populations of many flowering plants are being impacted. The synergistic affects occurring with exposure to neonicotinoids, glyphosate, chlorothalonil and other fungicides appears to be contributing to major die-offs of honeybees and native pollinators. (Boily M, Sarrasin B, Deblois C, Aras P, Chagnon M., Acetylcholinesterase in honey bees (Apis mellifera) exposed to neonicotinoids, atrazine and glyphosate: laboratory and field experiments. Environ Sci Pollut Res Int. 2013 Aug;20(8):5603-14. doi: 10.1007/s11356-013-1568-2) (Jeffery S. Pettis, Elinor M. Lichtenberg, Michael Andree, Jennie Stitzinger, Robyn Rose and Dennis vanEngelsdorp, July 24, 2013, Crop Pollination Exposes Honey Bees to Pesticides Which Alters Their Susceptibility to the Gut Pathogen *Nosema ceranae*. DOI: 10.1371/journal.pone.0070182)

Working Hypothesis: **The chelating actions by glyphosate on plants and many animals, result in the following, all of which can affect the carbon dioxide levels in the atmosphere and thus may have significant effects on the climate of the planet.**

1. Magnesium (Mg) deficiency (in addition to the other mineral deficiencies) reduces the plants ability to utilize sunlight to produce new plant cells or in the case of one-celled plants, to divide into new cells. This is because "magnesium has a number of key functions in plants. Particular metabolic processes and reactions that are influenced by Mg include: 1) photophosphorylation (such as ATP formation in chloroplasts), 2) photosynthetic CO_2 fixation, 3) protein synthesis, 4) chlorophyll formation, 5) phloem loading, 6) partitioning and utilization of photoassimilates, 7) generation of reactive oxygen species, and 8) photo-oxidation in leaf tissues. Consequently, many critical physiological and biochemical processes in plants are adversely affected by Mg deficiency." (www.kali-gmbh.com/en/pdf.../article-201006-better-crops-magnesium). If this is happening to plants all over the Earth, both land and water, decreasing the amount of CO_2 all plants use, it would greatly contribute to the increase in CO_2 in the atmosphere.

2. Rachel Carson stated in her book *Silent Spring*, published in 1962, that DDT and 2,4-D, which had been used for over 15 years, were killing the phytoplankton in the ocean, thus decreasing removal of CO_2 from the atmosphere. This warning was blatantly ignored.

Roundup first went on the market in 1974. Since the 1970s photosynthesis by phytoplankton in the ocean has decreased by over 40%, thus removing far less CO_2 from the atmosphere (Daniel G. Boyce, Marlon R. Lewis & Boris Worm, **Global phytoplankton decline over the past century**, *Nature* 466, 591–596 (29 July 2010) doi:10.1038/nature09268). Photosynthesis by phytoplankton has declined even more rapidly since 1994. Moreover, the decrease in phytoplankton, overexploitation by humans, and direct affects by exposure to Roundup and other mineral-chelating toxins, resulting in mineral deficiencies in the animals, likely is also contributing to the crash in ocean life, including corals, fish, marine mammals, etc. Interestingly, global climate change is blamed for these serious effects on the ecosystems. However, the increase in CO_2 in the atmosphere should increase rates of photosynthesis, as more carbon is available for fixation. Beginning in 1945, with increased burning of fossil fuels resulting in amplified acidification of the oceans, pesticides (umbrella term) were likely at least partly responsible for initiating the decrease in phytoplankton. The decrease in phytoplankton results in less CO_2 being removed from the atmosphere, causing an even greater decline in the phytoplankton because of changes in the ocean due to warming. Thus accelerating a classic downward spiral augmented by all the other above listed causes of Global climate change.

3. Glyphosate affects changes in the availability of minerals to the cells and thus to normal functioning of the cells. Within a forest, mineral deficiencies in the trees and in many of the soil microorganisms, funguses, etc. with which the tree roots interact, would obviously affect the ability of the trees to protect themselves from the tree killing insects (http://npic.orst.edu/factsheets/glyphotech.pdf). Bark beetles and other insects have killed billions of trees in North American forests in the U.S. and Canada since 1994. An earlier widespread beetle-kill event began in the late 1970s and peaked in the mid-1980s (K. F. Kipfmueller & T. W. Swetnam, **Climate and Mountain Pine Beetle-Induced Tree Mortality in the Selway-Bitterroot Wilderness Area**, Final Report to the USFS Research Joint Venture Agreement #RMRS-99611-RJVA January 2002). The 1970s to mid-1980s corresponded in time to the extensive use of 2-4,5-T and Endrin (both of which were banned in 1985.) The latest extensive beetle kills in North American forests began immediately after 1994 (see above reference, Kipfmueller & Swetnam, 2002) exactly at the time when the huge increase in use of glyphosate (the most used herbicide) and Chlorothalonil (the most used fungicide) began throughout the U.S. and Canada. The current outbreak in British Columbia covers a much greater area and is more severe than all previous recorded outbreaks. The reduction in uptake of CO_2 and consecutive release of carbon resulting from the death of billions of evergreen trees would accelerate global climate change. “The cumulative impact of the beetle outbreak in the affected region during 2000–2020 will be *270 megatonnes (Mt) carbon* (or 36 g carbon m-2 yr-1 on average over 374,000 km2 of forest). This impact converted the forests from a net carbon sink to a large net carbon source” (W. A. Kurz, et. al., **Mountain pine beetle and forest carbon feedback to climate change**, *Nature* **452**, 987-990 (24 April 2008) | doi:10.1038).

4. With exposure to glyphosate and consequent mineral depletion contributing to higher tree mortality, the abundance of dead trees in the forests, less rainfall and higher summer temperatures result in hotter, more intense wildfires. Burning large amounts of plant material in wildfires releases tons of CO_2 and other chemicals into the atmosphere. Burning causes the many toxic chemicals that have built up on the foliage to be released directly into the air. Heat alters some of the chemicals in the burning wood and soil into new, often more toxic chemicals. Many of those

heat-formed chemicals are even more active as greenhouse gasses than the parent chemicals.

5. Many microorganisms in the soil and vital soil funguses have been shown by multiple studies to be damaged or completely killed by glyphosate, while other, more harmful microbes and fungi may thrive. Loss of vital soil organisms further reduces the rates of removal of CO_2 from the atmosphere, contributing to global climate change. This study shows glyphosate kills beneficial soil fungus: (P. Chakravarty and S. S. Sidhu, 2007, **Effect of glyphosate, hexazinone and triclopyr on in vitro growth of five species of ectomycorrhizal fungi.** DOI: 10.1111/j.1439-0329.1987.tb01017.x).

6. Glyphosate also kills many insects and the animals that eat insects, such as ladybugs, bats, spiders and birds. A study shows that plants actually "fixate more carbon when they are being attacked by insects that are being held at bay by higher order animals that eat them like spiders, as compared to plants that live in an isolated environment where there are neither insects nor predators." The study reference for the effect of predators on carbon fixation by plants is (Oswald J. Schmitz, et. al., **From Individuals to Ecosystem Function: Toward an Integration of Evolutionary and Ecosystem Ecology**, Vol. 89, No. 9 (Sep., 2008), pp. 2436-2445 Published by: Ecological Society of America Stable URL: http://www.jstor.org/stable). To read articles about the study, type "predators help plants put away carbon" on Google. Since Roundup is falling in rain and snow all over the planet, all plants and the species that depend on them are being affected by exposure to glyphosate. This alone would contribute to global climate change.

7. Glyphosate is not alone in its impact on carbon cycling. Chlorothalonil in very low amounts was shown in a study done by Jason Rohr at the University of South Florida (doi:10.1111/j.1461-0248.2012.01790.x), to profoundly reduce biodiversity and disrupt ecosystem function. All the amphibians, insects, many zooplankters, and decomposers died, ultimately resulting in an algae bloom similar to those caused by eutrophication. Neonicotinoid insecticides, especially Imidacloprid, cause aquatic insects to die by impairing movement and thus feeding, causing starvation (doi:10.1371/journal.pone.0062472), as well as causing immune system repression (DOI: 10.7178/jeit.1). Plus, as stated above, glyphosate contributes to the mortality of both freshwater plants and animals by chelating vital minerals. Thus glyphosate works synergistically with the Chlorothalonil and the Imidacloprid in the natural environment, likely resulting in even faster changing of the ecosystem to nuisance-algae dominance. Such algae remove CO_2 from the atmosphere, but less than a fully functioning ecosystem with a diversity of aquatic plants, micro- and macroalgae, and the zooplankton and other organisms that can occur in a healthy freshwater ecosystem. Since all three types of pesticides fall in the rain and snow into all freshwater ecosystems, the total decline in global CO_2 removal by freshwater plants could be significant.

8. The effects of glyphosate and other pesticides on bird mortality. Birds, especially hatchlings, have been documented with developmental malformations, such as heart defects, lung damage, disrupted feather development and most telling, underdeveloped upper bills, as have been shown to be directly caused by mineral deficiencies and thyroid hormone disruption during development. Declining populations of insect-eating birds will favor increases in nuisance-insect populations. At the same time, beneficial insects are also being harmed and are thus declining. The consequent effects on plants would definitely affect global carbon uptake by plants. Because glyphosate chelates minerals, mineral deficiencies that cause thyroid hormone disruption and thus developmental malformations on birds are likely the result of glyphosate and other pesticides affecting the mineral levels in the plants, insects and in the birds themselves. There has been a noted decrease in the populations of many kinds of birds that eat seeds and insects. There has been a corresponding decline in rodent species, along with observed increases in developmental malformations in

rodents, likely also connected with mineral deficiencies. Developmental malformations and problems with the liver and digestive system have been noted on several common rodent species. A decline in rodents leaves less food for raptors, thus seriously affecting the survivability of the young, even if the young birds do not have developmental malformations.

Glyphosate was shown to have adverse affects on beneficial bacteria in poultry microbiota, while potential pathogens for avian species were shown to be resistant to glyphosate, not a good combination for the health of birds. (Awad A. Shehata, et. al., 2012, **The Effect of Glyphosate on Potential Pathogens and Beneficial Members of Poultry Microbiota In Vitro,** DOI 10.1007/s00284-012-0277-2). Large die-offs of birds caused by pathogens often occur several days after a moist weather front moves through an area. Moist weather fronts have been shown by multiple studies to carry numerous toxins, including glyphosate and Chlorothalonil. Chlorothalonil was shown to greatly enhance growth rates of pathogens such as *Salmonella* ssp. and *E. coli*. (Tat Yee Guan, Greg Blank, Anne Ismond and Rene Van Acker, 2001, **Fate of foodborne bacterial pathogens in pesticide products,** Journal of the Science of Food and Agriculture. DOI: 10.1002/jsfa.835). Thus, exposure to a combination of the most used herbicide in the U.S. and the most used fungicide in the U.S. would likely have serious short and long-term affects on the health and survivability of birds.

A study by Pierre Mineau (Direct losses of birds to pesticides – beginnings of a quantification. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191, 2005. www.fs.fed/us/psw_gtr191_1065-1070-mineau) shows a direct relationship between pesticide use and bird deaths.