MONARCHS IN PERIL

HERBICIDE-RESISTANT CROPS AND THE DECLINE OF MONARCH BUTTERFLIES IN NORTH AMERICA

CENTER FOR FOOD SAFETY

EXECUTIVE SUMMARY
FEBRUARY 2015

ABOUT CENTER FOR FOOD SAFETY

CENTER FOR FOOD SAFETY (CFS) is a non-profit public interest and environmental advocacy membership organization established in 1997 for the purpose of challenging harmful food production technologies and promoting sustainable alternatives. CFS combines multiple tools and strategies in pursuing its goals, including litigation and legal petitions for rulemaking, legal support for various sustainable agriculture and food safety constituencies, as well as public education, grassroots organizing and media outreach.

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THE MONARCH BUTTERFLY IS IN SERIOUS TROUBLE—their numbers have plummeted over the past two decades. The butterfly's decline tracks the virtual eradication of its caterpillar's chief food source—common milkweed—from Midwestern cropland. The demise of milkweed is due to intensive spraying of glyphosate herbicide on Monsanto's Roundup Ready corn and soybeans that have been genetically engineered to withstand it. Monarchs are in imminent danger unless milkweed is restored to Midwestern crop fields. Milkweed cannot recover with continued heavy use of glyphosate on Roundup Ready crops. We face a historic choice: do we want to protect Monsanto or monarchs? The threats to monarch survival will soon escalate, if new genetically engineered (GE) crops resistant to glyphosate and additional herbicides like 2,4-D and dicamba are introduced. Federal decision-makers must understand that to save monarch butterflies in North America, we must prevent their habitat from being destroyed by ever more intensive spraying of weed-killers on GE herbicide-resistant crops.

[This executive summary highlights the key points of a comprehensive, fully documented report of the same title by Center for Food Safety, available at: www.centerforfoodsafety.org/reports.]

Monarch numbers have fallen by 90% in just 20 years, and entomologists fear that the spectacular migration of these iconic butterflies is coming to an abrupt end.

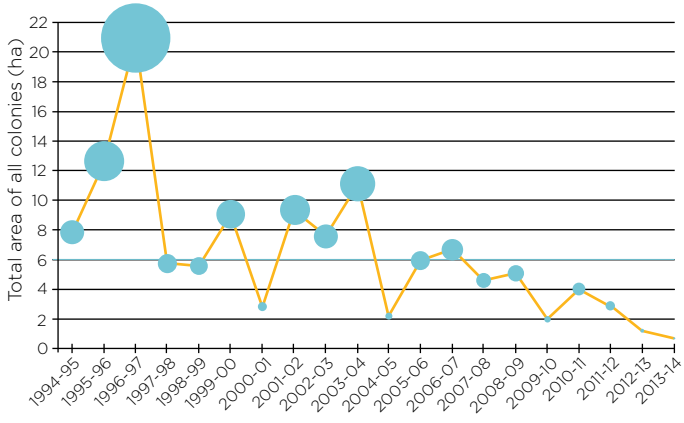
MONARCHS IN PERIL

The striking orange and black monarch butterfly is beloved across North America, renowned for its beauty and spectacular migration.[1] From late summer through autumn, millions of monarchs from east of the Rocky Mountains stream south, flying over a thousand miles to converge on a few acres of forest in central Mexico. Monarchs that survive the perils of winter in Mexico fly north in the early spring. While the journey south is made by a single generation of butterflies, their return north spans several. The monarchs that overwintered in Mexico reach the southern U.S. in spring. Their descendants then continue north, over several generations fanning out to populate the Midwest and Eastern United States. Monarchs progress as far north as Canada before the last generation heads south again for the winter. It is an incredible journey that continues to captivate people around the world.

Tragically, the monarch population of 2013/2014 was by far the smallest ever recorded, capping a precipitous two-decade decline (Figure 1).[2] Monarch numbers have fallen by 90% in just 20 years, and entomologists fear that the spectacular migration of these iconic butterflies is coming to an abrupt end.[3]

Although there are many factors at play, a critical driver of monarch decline is the loss of host plants for larvae in their main breeding habitat, the Midwestern Corn Belt.[4] Monarchs lay eggs exclusively on plants in the milkweed family because it is the only food their larvae can eat. Monarch caterpillars consume milkweed leaves, molt several times, and then form beautiful lime-green pupae suspended from leaves or stems. In as little as ten days, the metamorphosis from chrysalis to adult is complete, and the new butterflies emerge. However, milkweed has been largely eradicated from corn and soybean fields where it used to be common, depriving monarchs of the plant they require for food and reproduction.[5]

Figure 1. Area of monarch overwintering habitat in Mexico: 1994/95 - 2013/14.



Adapted and extended from Brower et al. (2011). See endnote 3.

Milkweed has been largely eradicated from corn and soybean fields where it used to be common, depriving monarchs of the plant they require for food and reproduction.

To initiate much-needed action by the federal government, Center for Food Safety and partners filed a legal petition with the U.S. Fish and Wildlife Service to protect monarchs as threatened under the Endangered Species Act (ESA). In December 2014, the Service responded to this petition and announced that ESA listing may be warranted, an important first step towards securing stronger protections for monarch butterflies. Policy recommendations for other federal agencies are listed in the final section.

COMMON MILKWEED IN 20TH CENTURY AGRICULTURE

FARMING *PER SE* IS NOT THE PROBLEM. Monarch butterflies have coexisted with agriculture ever since the prairies and forests of the Midwest were converted to cropland in the late 1800s.[6] Monarchs have been able to thrive in a landscape dominated by agriculture because just one of many North American milkweed species—*Asclepias syriaca,* or common milkweed—is remarkably well-adapted for life on disturbed ground, such as plowed fields, cleared woodlands, and roadsides.[7] This one species was able to largely replace the other kinds of milkweeds that hosted monarchs before prairies were plowed under and forests cut down.[8]

In 1980, common milkweed occupied at least 26 million acres in the 13 north central states. Iowa, Nebraska, and Wisconsin had the most land with milkweed, which was most frequently found in corn and soybean fields.[9] Common milkweed continued to be prevalent in Midwestern cropland throughout the 1980s and 1990s.[10]

How was common milkweed able to survive in 20th century agriculture? The short answer is tough, regenerative roots. Common milkweed is a perennial plant with an extensive system of spreading roots.[11] The plant's aboveground shoots die back in the winter, but re-sprout from root buds each spring. Milkweed similarly regrows after it is mowed or treated with most herbicides, since the roots remain largely unaffected. Even when tillage dismembers roots, the larger sections can still regenerate new plants.[12] Thus, common milkweed in and around corn and soybean fields supported a large population of monarch butterflies throughout the 20th century.[13] In fact, a landmark study published in 1998 showed that roughly half of the monarchs in Mexican winter roosts had developed on common milkweed plants in the Corn Belt, making this by far the most important habitat for maintaining the migratory monarch population.[14]

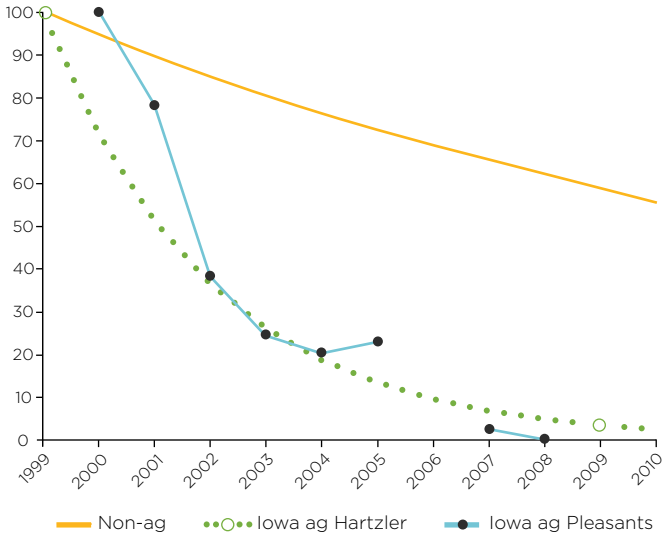
Common milkweed has been nearly eliminated from Midwestern agricultural fields thanks to intensive, mid-season application of glyphosate to the vast majority of corn and soybean fields that are planted to Roundup Ready varieties.

THE DECLINE OF COMMON MILKWEED

FROM A SUCCESSFUL INHABITANT of cropland throughout the 20th century, common milkweed populations have plummeted in the 21st. The best evidence comes from rigorous weed surveys conducted in Iowa and Minnesota, though reports from other states make it clear that milkweed is disappearing from corn and soybean fields throughout the Midwest.

In 1999 and 2009, Iowa State University scientists conducted comprehensive surveys that established the prevalence and distribution of common milkweed in both crop fields and non-agricultural land throughout the state.[15] In 1999, common milkweed was found in half of Iowa corn and soybean fields, but in only 8% just a decade later. Where milkweed *was* found, it was nearly five times less abundant. The declining number of fields with milkweed, and the reduced density where it was found, translate to a startling 96.5% decline in cropland milkweed from 1999 to 2009 (Figure 2, Iowa-ag Hartzler). It is estimated that just 1% of the common milkweed present in Iowa corn and soybean fields in 1999 remained by 2013.[16] These results are corroborated by a second, more limited survey conducted by Iowa entomologist John Pleasants. Pleasants charted declining milkweed populations in seven fields from 2000 to 2008. Of roughly 1,000 milkweed stems at the start of his survey, none remained by 2008[17] (Figure 2, Iowa-ag-Pleasants).

Figure 2. Change in milkweed density in Iowa: agricultural and non-agricultural habitats.



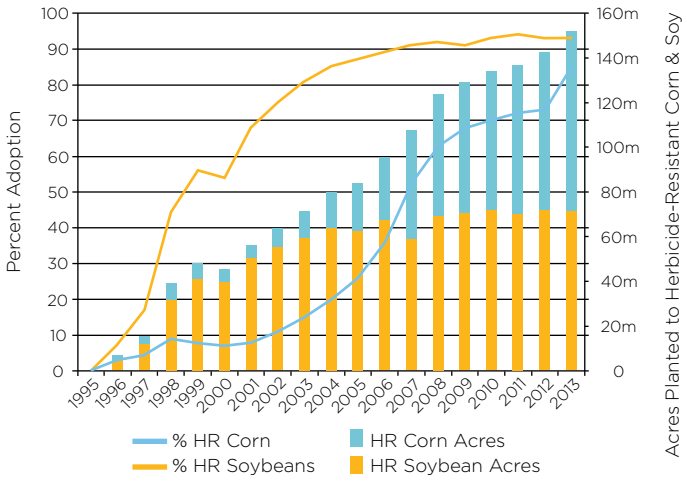
Updated from Pleasants and Oberhauser (2012), Figure 1, supplied by authors. See endnote 4.

Milkweed surveys conducted from 2003 to 2005 in Minnesota reveal a similar picture,[18] as do reports of milkweed loss in Kansas, Nebraska, and other Midwestern states where milkweed was once quite prevalent. This evidence leaves little doubt that milkweed is being eradicated from cropland throughout the Midwestern states that make up the heart of monarch breeding grounds.[19]

ROUNDUP READY CROPS UNLEASH GLYPHOSATE

THERE IS ALSO NO DOUBT what has driven the elimination of milkweed. Roundup Ready corn and soybeans are genetically engineered to survive spraying with the herbicide glyphosate, sold by Monsanto as Roundup but also in many generic versions by other companies. Glyphosate is an extremely effective herbicide that kills practically all green plants. It is particularly prized for its efficacy on perennial weeds like common milkweed that other herbicides fail to kill.[20] Unlike most weed-killers, glyphosate is absorbed by the plant and accumulates in the roots, developing root buds, and other actively growing tissues. By killing common milkweed at the root, regrowth the following year is largely prevented.[21]

Figure 3. Adoption of genetically engineered, herbicide-resistant corn and soybeans in the U.S.

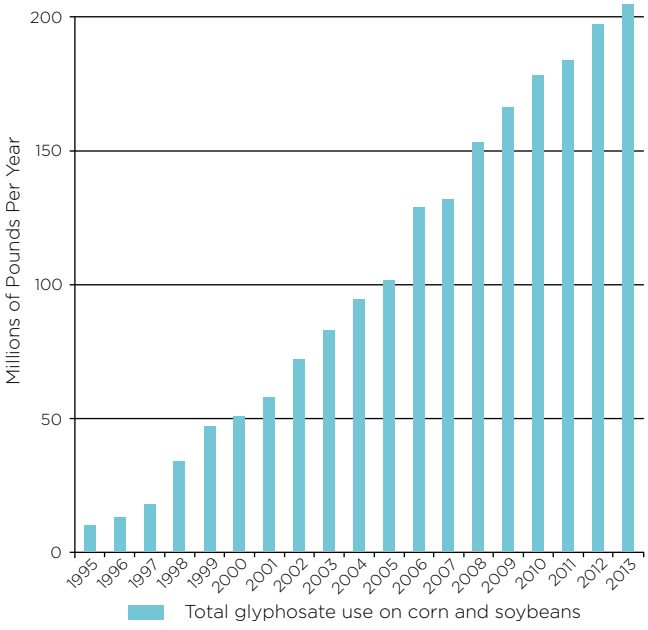


Based on US Dept. of Agriculture data. See Full Report, Section 3.3.

Glyphosate was introduced in 1974, but for two decades it was used very little in corn and soybean farming. The chief factor inhibiting broader use was crop injury: glyphosate kills crops as well as weeds. This meant that for the most part, glyphosate could only be applied early in the season to clear a field of weeds before planting (or before seedlings emerged) to avoid crop injury.

Roundup Ready crops unleashed glyphosate. Thanks to their genetically engineered immunity, this powerful, milkweed-killing herbicide could now be sprayed "over the top" of the crop to kill weeds through much of the growing season. Monsanto introduced Roundup Ready soybeans in 1996 and Roundup Ready corn in 1998. Figure 3 shows how rapidly these new GE crops came to dominate U.S. agriculture: first soybeans, and then corn. Today, Roundup Ready varieties of corn and soybeans are grown on 150 million acres, representing 90% of U.S. soybeans and over 80% of corn.

Figure 4. Glyphosate use on corn and soybeans in the U.S.: 1995-2013.



Based on US Dept. of Agriculture data. See endnote 22.

Glyphosate use on corn and soybeans has risen dramatically thanks to Roundup Ready crops, from just 10 million lbs in 1995 to 205 million lbs in 2013 (Figure 4).[22] This represents an extraordinary 20-fold increase over just 18 years, and makes glyphosate by far the most heavily applied pesticide in U.S. agriculture.[23] Several aspects of this Roundup Ready revolution in glyphosate use are relevant to the fate of common milkweed.

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INCREASED AREA TREATED

Prior to the Roundup Ready crop era, common milkweed in crop fields was able to survive because most of it escaped any exposure to glyphosate. Only 13% of total corn and soybean acreage was sprayed with glyphosate in 1995, just one of every eight acres.[24] The rapidly increasing share of corn and soybean fields treated with glyphosate since then tracks Roundup Ready crop adoption (Figure 3), and coincides with common

A RECIPE FOR DISASTER

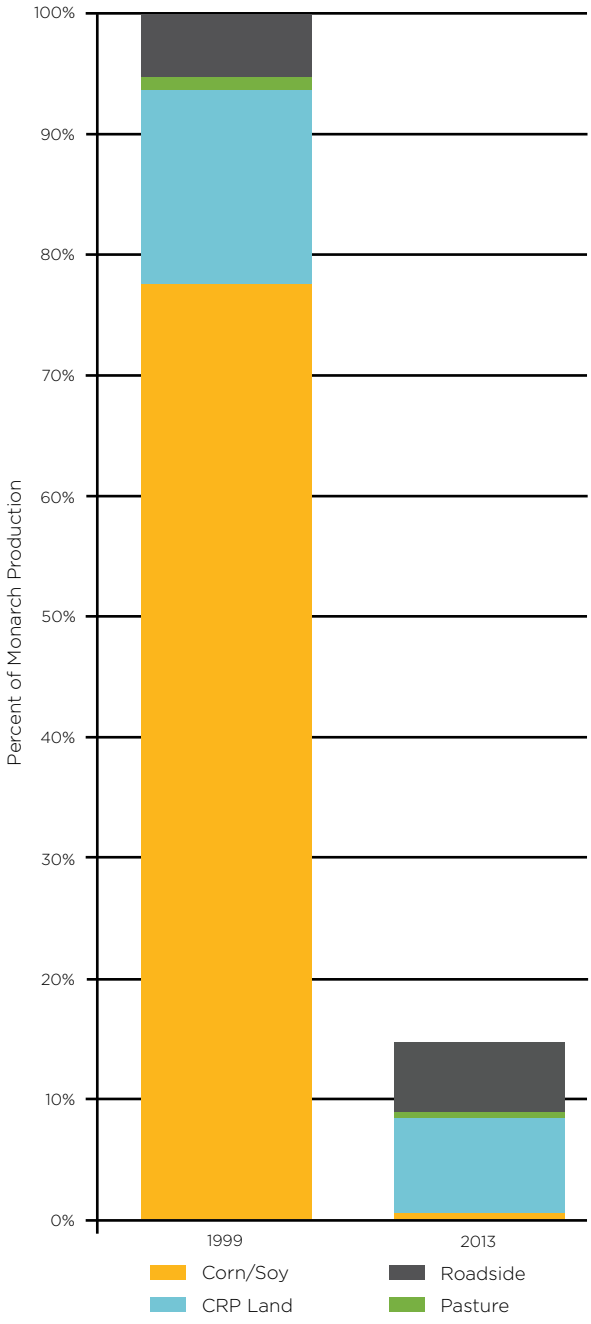
If someone were to intentionally concoct a recipe for how to get rid of milkweed, one could do no better than the Roundup Ready crop system. Glyphosate is one of the very few herbicides that kills common milkweed, and it is particularly detrimental when sprayed later in the season on Roundup Ready corn and soybeans.

Now that over 90% of fields are sprayed with glyphosate every year, only about 1% of the milkweed plants present in Midwestern corn and soybean fields in the late 1990s remain.

Unfortunately, the devastation extends beyond milkweed. Flowering plants that provide adult monarchs with nectar are also under siege from increasing herbicide use and drift. Next generation genetically engineered crops resistant to volatile herbicides such as 2,4-D and dicamba, as well as glyphosate, will dramatically exacerbate these impacts. Because most wildflower habitat is found near corn and soybean fields in the Midwest, increased herbicide use and drift will reduce nectar resources that monarch adults require for breeding and for their epic migration.

milkweed's eradication. Today, nearly all corn and soybeans (91%) and what little common milkweed remains there are sprayed with glyphosate. For perspective, these 157 million glyphosate-treated corn and soybean acres represent half of all harvested cropland in the entire country.[25]

Figure 5. Estimated production of monarchs in the Midwest by habitat type: 1999 and 2013.



Estimated proportion of monarchs produced on milkweed from different habitats, relative to monarch production in 1999. See Full Report, Section 4.5, for sources.

RISING INTENSITY OF USE

Glyphosate is not only being applied to vastly more acres than ever before, it is also being sprayed more intensively. The average amount of glyphosate applied to soybeans per acre per year climbed from 0.61 lbs in 1995 to 1.53 lbs in 2013, a 150% or 2½-fold increase. A similar though less pronounced trend is evident in corn over the same years: from 0.64 to 1.10 lbs/acre per year, for a 72% rise. This increasing intensity involves both higher rates per application and more applications per season, and is another important factor in common milkweed's demise.[26] In addition, the increasingly common practice of growing Roundup Ready crops continuously on the same fields means that milkweed is sprayed with glyphosate every year, without time to recover.

APPLICATION LATER IN THE SEASON

Roundup Ready crops have also shifted glyphosate applications two to six weeks later into the growing season.[27] In the Midwest, glyphosate is generally sprayed in May when used with conventional crops, but in June through early July with GE corn and soybeans. The later application of glyphosate with Roundup Ready crops coincides with common milkweed's reproductive phase (budding and flowering), when it is most susceptible to glyphosate's killing effects.

Common milkweed has been nearly eliminated from Midwestern agricultural fields thanks to intensive, mid-season application of glyphosate to the vast majority of corn and soybean fields that are planted to Roundup Ready varieties.

AGRICULTURAL MILKWEED ESSENTIAL TO SUSTAIN MONARCH POPULATION

Milkweed growing in Midwest cropland is essential to the monarch's continued survival.[28] This is because the Corn Belt is the monarch's major breeding range, and corn and soybean fields dominate the Midwest landscape. It is estimated that in just the 13 years from 1999 to 2012, corn and soybean fields in Iowa lost 98.7% of

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their milkweed, representative of milkweed decline throughout the Corn Belt.[29] Because monarchs produce nearly four times more offspring per plant on milkweed growing in cropland than on milkweed growing in other areas (*see box on page 11*), this loss has had a tremendous impact on monarch population numbers. Thus, it is estimated that the Midwest produced 88% fewer monarchs in 2012 than it did in 1999.[30] Figure 5 illustrates how the great majority of this huge decline in monarchs is due to loss of milkweed from corn and soybean fields.

Although milkweed does grow outside of cropland, there is not enough habitat to support a viable monarch population. And milkweed is declining in these areas as well. The prevalence of milkweed in pastures and retired farmland enrolled in the Conservation Reserve Program (CRP), and the number of monarchs they produce, have fallen by more than 50% since 1999 (Figure 5).[31] The CRP is a USDA-sponsored program that pays farmers to take environmentally sensitive land out of crop production for 10-15 year periods, and instead sow grasses and other plants that improve environmental quality. The amount of land in the CRP has fallen steeply since 2007 as farmers put their fields back into crop production,[32] enticed by high corn prices stoked by the federal government's subsidies and quotas for corn-produced biofuels.[33] Land in this program will continue to shrink in the future thanks to the 2014 Farm Bill, which reduces the maximum CRP acreage ("CRP cap") considerably through 2017.[34] These developments are extremely worrisome because milkweed plants growing on rapidly dwindling CRP lands are now responsible for more than half of today's depressed monarch population (Figure 5). Another sign of how difficult things have become for monarchs is that the narrow strips of land along roadways are now a major remnant habitat for milkweeds in the Midwest (Figure 5).

New chemically intensive crop systems present even more risks to monarchs and other wildlife. Comprehensive research on the full breadth of threats posed by these products and associated practices has not been conducted.

NEXT GENERATION OF GE CROPS WILL FURTHER DEGRADE MONARCH HABITAT

Pesticide companies are poised to introduce a host of "next-generation" GE crops resistant to both glyphosate and one or more additional herbicides.[38] These new chemically intensive crop systems present even more risks to monarchs and other wildlife. Comprehensive research on the full breadth of threats posed by these products and associated practices has not been conducted.

These crops are being promoted as a "fix" to glyphosate-resistant weeds generated by Roundup Ready crop systems, but they will rapidly foster still more intractable weeds resistant to multiple herbicides.[39]

These new GE crops will be sprayed with a formulation of glyphosate and an additional herbicide. Dow AgroSciences has developed Enlist Duo, which contains the herbicides 2,4-D and glyphosate, to be sold in tandem with its 2,4-D/glyphosate-resistant soybeans, corn, and cotton.[40] Similarly, Monsanto has developed Roundup Xtend herbicide, which combines dicamba and glyphosate, for use on its dicamba/glyphosate-resistant soybeans and cotton.[41] Dow has projected that its new GE corn and soybeans will increase agricultural use of 2,4-D by three- to seven-fold over current levels by 2020,[42] and Monsanto's new GE crops will lead to a similar increase in the use of dicamba[43] (see also Figure 6). Glyphosate will continue to be sprayed at current high levels.

IMPORTANCE OF AGRICULTURAL MILKWEED

Scientists have made a fascinating discovery: monarchs prefer milkweed growing in crop fields. From 2000 to 2003, Iowa State University entomologist John Pleasants carefully counted the monarch eggs laid on milkweed plants growing in agricultural habitats (corn and soybean fields), and on those growing in adjoining or nearby non-agricultural habitats (natural areas, pastures, old fields, and roadsides). He observed a consistent pattern. In each year, the agricultural milkweed plants had from 3 to 5 times more monarch eggs than non-agricultural milkweed (3.89 times more, on average).[35] These results matched previous findings in Iowa, Minnesota, and Wisconsin, which also found that a similar proportion of eggs survived to adulthood in all habitats.[36]

Why do monarchs produce more offspring on milkweed plants in agricultural fields? No one knows for sure, but several possible explanations have been offered:[37] females may prefer agricultural milkweed because their larvae are less subject to predation or parasitism; because agricultural milkweed leaves have higher nitrogen content, potentially making them more nutritious for monarch larvae; or because the milkweed chemical signal that attracts monarch females may be more apparent against the monoculture background of crop fields, making it easier for females to find milkweed there.

Scientists have made a fascinating discovery: monarchs prefer milkweed growing in crop fields. In each year, the agricultural milkweed plants had from 3 to 5 times more monarch eggs than non-agricultural milkweed.

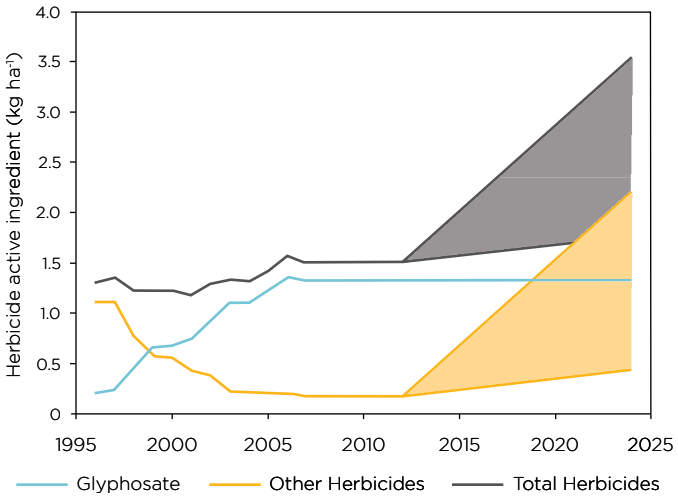
2,4-D and dicamba cause considerable damage to milkweed,[44] and when combined with glyphosate are even more potent milkweed killers.[45] As these new GE crops replace Roundup Ready varieties, milkweed will continue to be eradicated from cropland at undiminished rates, and have no chance to re-establish.

The next generation of GE crops also threatens to destroy countless more flowering plants that adult monarch butterflies require for sustenance. Unlike monarch caterpillars, which feed exclusively on milkweed leaves, adult butterflies require an abundant array of nectar-producing flowers to sustain themselves during breeding. In addition, the generation of butterflies that migrates south in the fall depends on nectar sugars (stored in the form of fat) to sustain themselves while overwintering in Mexico, and also to fuel their northern migration the following spring.[46]

By definition, herbicides are toxic to plants.Various models of herbicide spray drift suggest that 1% (commonly) to 25% (occasionally) of the applied herbicide dose drifts beyond the field boundaries to affect wild vegetation.[47] Herbicide use on crops has been connected with decreased quantity and variety of flowering plants in hedges, along field edges, and within fields themselves.[48] Flowers may also bloom later and over a shorter span of time in places where weed-killers are routinely sprayed.[49]

Because herbicides are applied more frequently, at higher rates, and later in the season when used with GE crops, they are even more likely to harm sensitive nectar plants.[50]

Figure 6. Projected herbicide use with soybeans resistant to 2,4-D and dicamba.



Mortensen et al. (2012), Fig. 4, original caption omitted. See caption in source paper (endnote 39) for assumptions.

Several studies suggest that glyphosate applied to Roundup Ready crops has already reduced the abundance and diversity of flowering plant populations in and around agricultural fields.[51]

2,4-D and dicamba-resistant crops will make things much worse. These herbicides are very prone to drift beyond the field where they are applied—both spray drift during application and vapor drift,[52] which can occur days to weeks after spraying.[53] 2,4-D and dicamba are already among the leading herbicides that cause drift-related crop injury,[54] and drift that damages crops is inevitably damaging wild plants as well. The dramatically increased and later-season use of these herbicides with next-generation GE crops will cause much more injury to flowering plants in areas near cropland, which provide most of the biodiversity in agriculture-dominated landscapes[55] like the Midwest. The resulting reduction in nectar sources may lead to poorly nourished monarchs that lay fewer eggs, or do not survive migration. Other pollinators will suffer as well.

Pesticide companies expect weeds to develop additional resistance, for instance to 2,4-D, and in response are already planning to make their GE crops resistant to still more weed-killers.[56] The spiraling herbicide use stemming from this chemical arms race between crops and weeds will be still more destructive of habitat for monarchs and many other species.

The threats described above—milkweed eradication in corn and soybean fields, conversion of non-agricultural habitat to cropland, and introduction of new herbicide-resistant crops—imperil the very existence of monarch butterflies in North America.

ADDITIONAL THREATS TO MONARCHS

As the monarch population declines, other threats have greater impact, and the butterflies are less likely to bounce back from adversity.[57] For example, a winter storm in 2002 killed an estimated 468-500 million monarchs,[58] but the population then was large enough to sustain these losses and rebound. A similar storm today—ever more likely with climate change—could wipe out the current, much smaller, overwintering population.

Monarchs face threats throughout their range.[59] Illegal logging degrades winter roosting sites. Development paves over habitat. Predators and pathogens inflict high mortality at all stages of life. Skyrocketing use of neonicotinoid insecticides is also of great concern. Monarch numbers must be sufficiently high for the population to remain viable in the face of all these threats.[60]

FROM WEED ERADICATION TO WEED MANAGEMENT

The same pernicious agricultural practices that threaten monarchs also imperil many other species. Modern industrial agriculture is a major contributor to both the ongoing extinction crisis and climate change.

The ecological impacts of weed eradication as a goal are brought into sharp focus by the fate of milkweeds and monarchs in Roundup Ready corn and soybean fields. Although there are unique features of this monarch story, it serves to illustrate the importance of preserving biodiversity within and around crops, including a variety of weeds at some level. Technologies that help achieve the misguided ideal of total weed eradication threaten not only monarchs but a host of beneficial insects, birds, and other organisms as well. Pollinators, natural enemies of crop pests, and other valued wildlife are suppressed by the collateral damage wrought by heavy and frequent use of plant-killing chemicals with herbicide-resistant crop systems.

Weed management, according to agroecological principles and methods, must replace herbicidal weed eradication. This will require a fundamental shift in the mindset of many farmers and weed scientists, who for decades have operated on the principle that the only good weed is a dead one. While weeds of course require management, it is neither necessary nor desirable to completely eliminate them. Studies show that crops managed organically can yield as well as their conventionally grown counterparts despite several-fold higher weed densities.[61] And weeds can benefit crops by providing ground cover that inhibits soil erosion and attendant loss of soil nutrients, habitat for beneficial organisms such as ground beetles that consume weed seeds, and organic matter that when returned to the soil increases fertility and tilth.[62]

Farmers and agronomists have developed numerous cultural techniques that suppress weeds and in some cases provide other benefits as well, such as reduced soil erosion and increased soil fertility. These include complex crop rotations, cover crops, intercrops,[63] fertilization methods that favor the crop over weeds, and closer plant spacing, among other methods.[64] And when used sparingly in conventional systems[65] or more frequently in organic farming,[66] tillage is consistent with the maintenance of high soil carbon levels, which inhibits soil erosion.

The same pernicious agricultural practices that threaten monarchs also imperil many other species. Modern industrial agriculture is a major contributor to both the ongoing extinction crisis and climate change.

Monarch caterpillars consume milkweed leaves, molt several times, then form beautiful lime-green pupae suspended from leaves or stems. In as little as ten days, the metamorphosis from chrysalis to adult is complete, and the new butterflies emerge.

URGENT ACTION IS IMPERATIVE

Center for Food Safety and the Center for Biological Diversity, joined by the Xerces Society for Invertebrate Conservation and renowned monarch scientist Dr. Lincoln Brower, have filed a formal legal petition with the U.S. Fish and Wildlife Service to protect monarchs as threatened under the Endangered Species Act.[67] Obtaining listing for monarchs under the ESA will provide stronger protections for the butterflies and their habitat, lead to a federal recovery plan for key government agencies, and secure much needed funding for monarch conservation efforts nationwide.

In December 2014, the U.S. Fish and Wildlife Service responded to this petition and announced that Endangered Species Act protection may be warranted for monarch butterflies. Accordingly, the Service has initiated a one-year status review of monarchs.

POLICY RECOMMENDATIONS FOR RESTORING MILKWEEDS AND MONARCHS

Listing monarch butterflies under the Endangered Species Act is essential to their recovery and continued survival. ESA listing would complement and promote other efforts to restore monarchs on the part of government agencies, scientists, monarch support groups, farmers, and pesticide firms. We must utilize all the tools at our disposal to stem further monarch declines and provide the best chance of their survival and recovery. First and foremost, phasing out the use of herbicide-resistant crops would be the best means to restore milkweed and therefore monarchs.

Policy recommendations that have been proposed by organizations and scientists committed to protecting monarch butterflies include but are not limited to the following:

RECOMMENDATIONS FOR THE U.S. FISH AND WILDLIFE SERVICE (FWS)

1. The FWS should act expeditiously to list the monarch as a threatened species under the Endangered Species Act. Listing would be followed by development of a recovery plan and provide resources for restoration of breeding habitat. Earlier this year, Center for Food Safety and colleagues provided the Agency a legal and scientific blueprint for that listing. Listing would also lead to analysis of effects of future federal agency actions on monarchs and consultation with the FWS to address those effects, including developing reasonable and prudent alternative actions when appropriate.

2. During the development of monarch recovery plans, the FWS should actively engage citizen-scientist groups involved with monarch restoration efforts, public interest groups, and agronomists with expertise in sustainable agriculture.

RECOMMENDATIONS FOR THE U.S. DEPARTMENT OF AGRICULTURE (USDA)

3. The USDA should reject applications to approve new herbicide-resistant crops, and EPA should deny registrations of herbicides for use on them, unless or until appropriate restrictions are enacted to ameliorate their harms to milkweeds, monarchs and pollinators. Those agencies should consult under the ESA with the FWS to develop the appropriate restrictions.

4. Based on this significant new information regarding monarchs, the USDA should re-open its past assessments of herbicide-resistant crops pursuant to the National Environmental Policy Act (NEPA). The USDA should undertake new assessments of the effects of those approvals in full Environmental Impact Statements (EIS) or Supplemental EISs, and re-consider whether and if continued cultivation of these crops can occur without further threatening monarch populations.

5. The USDA should work with farmers and landowners to establish programs to foster populations of common milkweed on land enrolled in the Conservation Reserve Program.

6. The USDA should provide incentives to farmers to plant biodiverse "edges" around crop fields that are rich in milkweed and diverse flowering plants for pollinators that are protected from pesticides.

7. For anyone growing herbicide-resistant GE crops, the USDA, in consultation with EPA, should:

Require that growers follow mandatory integrated weed management protocols with an emphasis on non-chemical modes of weed management that allow for reduced use of herbicides; and

Establish geographic, temporal and/or spatial restrictions for the use of herbicides, in particular glyphosate, so as to protect the main summer breeding habitat of monarchs.

RECOMMENDATIONS FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

8. The EPA should consider the ongoing and imminent harm from the most damaging herbicidal products to monarchs and suspend, cancel or amend the current registrations for those products to mitigate that harm. Restrictions imposed via amended registrations and product labels could include but are not limited to: monarch/milkweed "refuge" requirements, geographical or temporal restrictions on use, requiring alternative weed control measures, stronger warnings and directions for use, and other measures.

9. The EPA should rapidly conclude its Registration Review of glyphosate, taking full account of the impacts on milkweed and monarchs.

RECOMMENDATIONS FOR CONGRESS

10. Levy a small fee on the sale of herbicide-resistant crop seed and/or on associated herbicides to fund education on and deployment of sustainable weed management techniques and restoration of milkweed to agricultural lands. A precedent for such an approach is Iowa's Groundwater Protection Fund, a portion of which partially funds the Leopold Center for Sustainable Agriculture.

11. Revoke or reduce the tax credits, subsidies and mandates for ethanol that are driving the conversion of grasslands and Conservation Reserve Program land to herbicide-resistant corn production.

12. Appropriate funds to facilitate regular monitoring and reporting on the health and population status of the monarch butterfly.

13. Create an Interagency Phase-Out Task Force that will provide Congress and Federal Agencies with a 10-year plan to phase out the use of herbicide-resistant crops.

RECOMMENDATIONS FOR STATES

14. States should reform roadside weed management practices to spare milkweed (e.g. eliminate use of glyphosate and other milkweed-toxic herbicides, and time mowing for optimum monarch development).

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