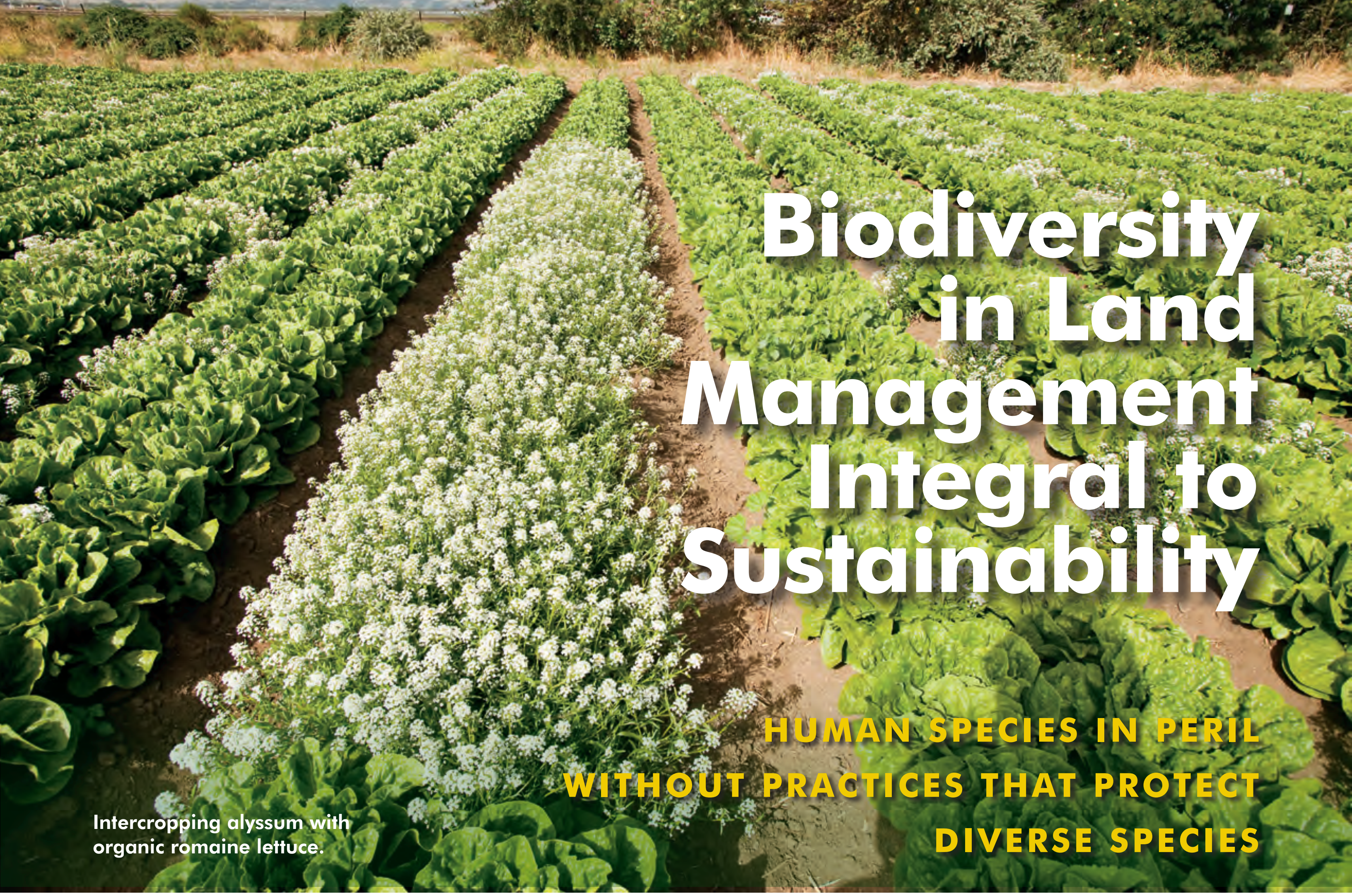
Biodiversity in Land Management Integral to Sustainability

HUMAN SPECIES IN PERIL WITHOUT PRACTICES THAT PROTECT DIVERSE SPECIES



Intercropping alyssum with organic romaine lettuce.

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Human life depends on biodiversity—the diverse range of organisms that forms a community of interdependent species, collectively contributing to a healthy and sustainable environment. By some scientific estimates, published in *Science*, "Current rates of extinction are about 1,000 times the likely background rate of extinction. Future rates depend on many factors and are poised to increase." That is the challenge, and the solution is within reach.

Biodiversity above ground and below ground, from the smallest to largest life forms, are interrelated in ways not yet fully understood. Nevertheless, the escalating extinction crisis is measureable and marked by events such as the loss of passenger pigeons, whose flocks filled the skies for days on end and whose consumption of "mast"—nuts and acorns—effected the transfer of nutrients over long distances. Less visible has been the fragmentation of the mycelial mat that connected trees from the Atlantic Ocean to the Mississippi River and facilitated the sharing of a food source that allowed stronger trees to support weaker trees. A large part of the solution to the global threat to biodiversity is rooted in decisions that are made on land management practices in agriculture and communities.

In a community of species in which humans coexist and interrelate with a variety of organisms, community members interact in complex ways. Microbes in the gut of humans help digest food, and microbes in the soil help feed plants. Many of the species that were once a part of daily life for people are now gone or very rare. They are gone for many reasons, but mostly because their homes were turned into farms and cities. Many species that enriched the lives of human ancestors no longer exist. Beyond enrichment, without those species, the communities they supported are undermined. The loss of these communities is seen in the proliferation of "invasive species," climate change, epidemics of disease and resistant microbes. This puts human survival at risk. Human sustainability requires the nurturing and survival of a diverse community of species from the bottom up, starting with the soil.

Chemical-Intensive Agriculture Harms Biodiversity

Chemical-intensive, or "conventional," agriculture, as practiced today, poses a devastating threat to biodiversity. Approximately two-fifths of U.S. land is farmland—915 million acres or 40.5% of land in the U.S. (USDA NASS, 2014), while 37.7% of the land area worldwide is used for agriculture (World Bank, 2013). The land area devoted to chemical-intensive agriculture in the U.S. dwarfs the 5.4 million acres or 0.59% of land that is farmed with organic practices that seek to nurture soil and ecosystem health while eliminating synthetic inputs incompatible with this goal. The other U.S. land uses, devoted to nonagricultural land purposes, includes 60.5 million acres or 2.6% of land in urban areas and 252 million acres (141 million of them in Alaska) of rural parks and wildlife space.

Farm practices are a critical contributor to the threat faced by a healthy and biodiverse ecology. Of the agricultural land in the U.S., 390 million acres (43%) are in cultivated crops, and more than half of that—220 million acres—is planted to three crops—field corn, soybeans, and wheat. Increasingly, these crops are grown in a monoculture (single crop, year after year) or short-term rotations (corn-soy-corn-soy, for example). In addition, pesticides are applied on:

- 100 million acres to kill insects (not including insecticide-coated or insecticide-engineered seeds),
- 286 million acres to kill weeds and brush,
- 14 million acres to kill nematodes,
- 35 million acres to control plant diseases, and
- 13 million acres to control growth, thin fruit, ripen crops, or defoliate crops (USDA NASS, 2012).

All of this pesticide use is designed to keep biodiversity at a minimum—to suppress the growth of species viewed as competition for the economic crop. In the case of species deemed beneficial to the crop, such as pollinators in numerous crops, the chemical-intensive farms require that the pollination services of beekeepers be brought in. The loss of biodiversity on farmland ultimately undermines the success of farmers around the world, as diverse ecosystems are more resilient to external stressors and more likely to prosper in spite of

Cover cropping in orchard.

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Pesticides Find Biodiversity as Their Target

Pesticides are labeled to control "target pests," but the idea that they kill only specific species has been proven false. In fact, product names themselves tell a different story, with examples such as Clean Field, Total Insect Killer, Prometon Total Kill, and The Spider and Insect Destroyer. Most insecticide labels display an extensive list of "target pests," along with a warning to avoid spraying when bees are in the field.

Numerous studies have found that pesticides have secondary effects not considered by the U.S. Environmental Protection Agency (EPA) or listed on the product label. In a 2016 study, researchers combined the results of approximately 1,000 observations for field studies across North America and Europe that had looked at the effect of neonicotinoid insecticide seed coatings on predatory insects. Predatory insects are reduced in study plots where coated seeds are planted, compared to the plots that are untreated by insecticides. In addition, the research findings conclude that coated seeds affect predatory insect populations similarly to soil and broadcast applications of pyrethroid insecticides.

Herbicides, such as glyphosate (Roundup), also function to eliminate a wide range of "weeds." The Roundup label demonstrates this, with the claim of "broad-spectrum control of many annual weeds, perennial weeds, woody brush and trees." These non-selective herbicides do not discriminate among plants, as they can kill or injure all plants that are present at the time of application, leading to an overall loss in biodiversity.

At the extreme are soil fumigants, applied to kill a wide range of organisms, including nematodes, fungi, bacteria, insects and weeds. The fumigant, Telone, used widely in agriculture to kill parasitic nematodes and control soil borne diseases, is fatal to humans if inhaled or swallowed and is toxic to mammals and birds. Widespread use of such products eliminates the soil diversity necessary to maintain ecological functioning.

So, despite a pesticide user's intention to kill only a particular "target" pest, pesticides generally kill much more indiscriminately. It is fair to say that the real target of pesticides is biodiversity itself.

Biodiversity as Defined by the National Organic Standards Board

Biological diversity (biodiversity) includes a variety of all forms of life, from bacteria and fungi to grasses, ferns, trees, insects and mammals. It encompasses the diversity found at all levels of organization, from genetic differences between individuals and populations (groups of related individuals) to the types of natural communities (groups of interacting species) found in a particular area. Biodiversity also includes the full range of natural processes upon which life depends, such as nutrient cycling, carbon and nitrogen fixation, predation, symbiosis, and natural succession.

Cover crops. © USDA

Conserving nesting sites. © Terry Shistar

them. By either knowingly or unknowingly contributing to biodiversity loss, farmers ultimately become more susceptible to pest pressures, disease, and drought.

Moreover, the landscape has become increasingly fragmented, containing pools of death merged into a sea of tiny islands with habitat. Conservation biologists now search for ways to create corridors linking such islands so that larger species will have enough habitat to survive. One review points out the unfortunate synergies among various threats: "Most forms of global change known to reduce population sizes and biodiversity will be exacerbated by fragmentation, including climate change, invasive species, hunting, pollution (including light, noise, and chemicals), and altered disturbance regimes."

Organic Agriculture Requires Biodiversity Protection

In making determinations on allowed materials in organic production, the National Organic Standards Board (NOSB), the stakeholder board created by Congress to oversee the implementation of the Organic Foods Production Act (OFPA), is required to consider "the effects of the substance [allowed in organic production] on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock." Moreover, organic regulations under the U.S. Department of Agriculture (USDA) define organic production as "a production system that is managed in accordance with the Act and regulations to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity." In promulgating the regulations, USDA said, "The use of 'conserve' establishes that the producer must initiate practices to support biodiversity and avoid, to the extent practicable, any activities that would diminish it. Compliance with the requirement to conserve biodiversity requires that a producer incorporate practices in his or her organic system plan that are beneficial to biodiversity on his or her operation."

Biodiversity brings benefits to the organic farm, but support of biodiversity on an organic farm also contributes to overall biodiversity in ways that go beyond the species living on the farm. Biodiversity in the soil food web of an organic farm leads to efficient cycling and retention of nutrients, control of soil-borne diseases and increased water-holding capacity and infiltration. Similarly, biodiversity above ground creates complex food webs, so that predators and parasites of crop-eating insects have shelter and alternative food sources. Predators, such as hawks, swallows, flycatchers, weasels, coyotes, frogs, snakes, and others, help to control rodents, insects, and other larger organisms that may pose problems on the farm.

In addition, organic farms that support diverse ecosystems contribute to larger scale biodiversity. Birds of prey and mammalian predators may not find sufficient food and shelter in a single piece of protected land. Adding habitat islands by way of organic farms can increase the land base that supports them. It also increases the diversity of landscapes, allowing greater numbers and types of plant and animal species to live in the area. This is especially important in a time characterized by "crop diversity loss and attendant homogenization of agricultural productions systems" in the U.S. (Aguilar et al., 2015). In promoting biological diversity in crops and landscapes, certified organic systems, as required by law, respect and harness biodiversity, while chemical-intensive systems do not.

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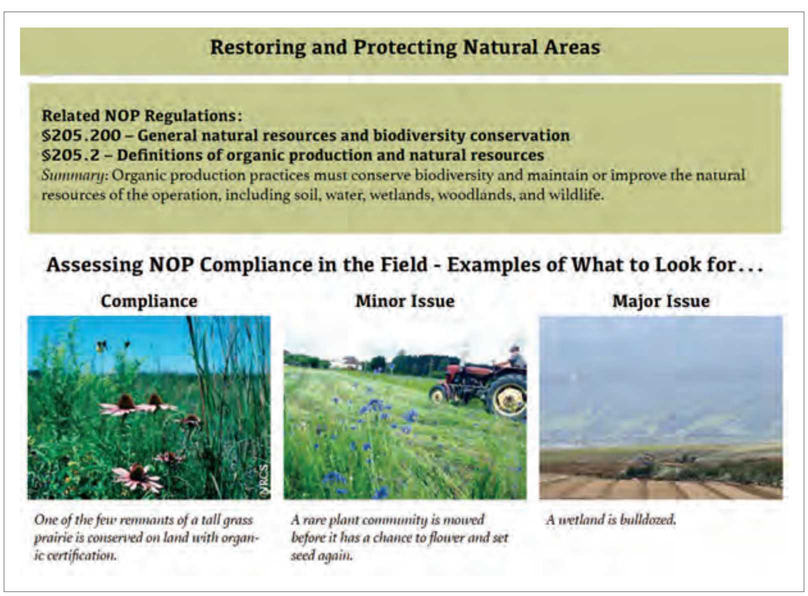
Pollinator plantings.

Despite legal requirements, and as the organic sector experiences a decade of sustained exponential growth, strict adherence to biodiversity conservation is an ongoing challenge. Assistance from the Natural Resources Conservation Service is available for many practices. The Wild Farm Alliance (WFA), a nonprofit organization that advances biodiversity on farms and the wider landscape, describes the spectrum of support for biodiversity:

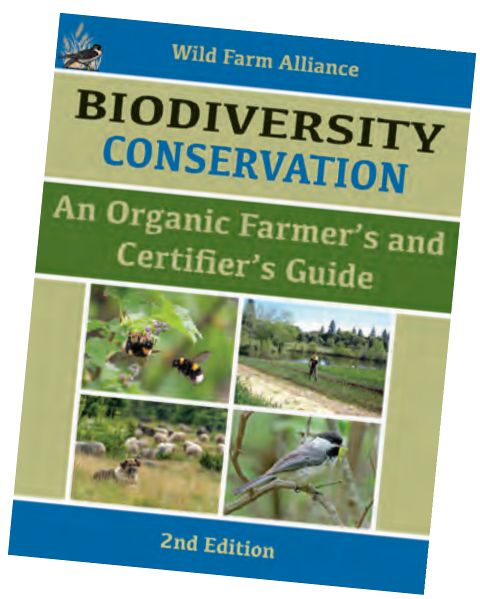
> On one end of the spectrum, less sustainable, more intensified agriculture occurs with outside fertility and pest control inputs, monocultures, conversion of perennial habitat to crop fields, large field sizes, and fragmented or absent habitat. As the farm moves toward self-sufficiency and complexity, it supports soil biodiversity, protects soil and water quality, and provides flowering plants and native habitat patches with structural and compositional diversity that link together and connect to wilder areas on and off the farm. On this end of the spectrum, the farm is highly diversified and integrated into the larger landscape.

WFA has worked with the NOSB, USDA's National Organic Program, organic certifiers, and organic farmers to incorporate biodiversity conservation into organic systems plans. WFA recently updated its *Biodiversity Conservation: An Organic Farmer's and Certifier's Guide*, which explains biodiversity principles and outlines activities that organic producers can use to maintain and increase biodiversity in their operations, including crops, livestock, wild harvest, and handling operations. Numerous examples are given to help organic producers comply with the requirements of OFPA and help certifiers and inspectors assess compliance. Although not all organic producers are being held to these requirements, the guide illustrates the degree to which OFPA is a preeminent environmental statute that requires biodiversity conservation.

It is important that organic farmers understand how their operations affect on-farm and landscape biodiversity before prioritizing their management practices. The principles discussed in WFA's Guide build upon the foundations of promoting healthy soil and clean water by using cover crops, filter strips, and maintaining riparian zones along waterbodies. A companion WFA publication to the guide, the *Biodiversity Continuum Chart*, outlines practices ranging from "simple" to "complex." As a producer moves along the continuum and



From *Biodiversity Conservation: An Organic Farmer's and Certifier's Guide*, Wild Farm Alliance, 2016.



Hedgerows along hayfield.

Protecting wildlife corridors, especially along streams.

begins implementing these practices, the benefits of a complex ecological system are realized through increased yields, reduced pest pressures, and reduction of disease.

Organic farms can support a diverse food web by planting native plants and hedgerows, which act as a source of food for beneficial predators. In addition to these practices, organic farms are at the forefront in sequestering carbon or regeneration, thus mitigating the harmful effects from elevated carbon dioxide in the atmosphere. Organic practices utilize intercropping or cover crops between crop rows, delivering nitrogen to the soil and capturing atmospheric carbon through plant photosynthesis and depositing it into the soil. The soil becomes a sink for carbon, contributing to soil health by feeding soil microorganisms that cycle nutrients to support healthy plants.

Understanding the Economics of Biodiversity

The estimated economic costs of losses to biodiversity in the form of pollinator services, "beneficial" predators, birds, aquatic life and microorganisms are continually changing as more complex and comprehensive studies are published. Early studies estimate that the cost of losses to biodiversity might amount to more than $1.1 billion every year (Tegtmeier & Duffy, 2004). As techniques for assessing ecosystem services and valuation of organisms become more complex, studies find the loss of biodiversity resulting in costs in the hundreds of billions of dollars annually. Natural pest control is estimated to be worth $100 billion a year globally, and the role of soil biota in increasing agricultural productivity just from soil formation is worth $25 billion a year globally (European Academies Science Advisory Council, 2015). In the U.S., pollinators add more than $24 billion to the economy, with honey bees making up for over $15 billion of that amount.

Conclusion

Protecting and nurturing biodiversity is not a choice, it is a necessity to support life. Conventional agricultural strategies to "reduce" pesticides, such as undefined Integrated Pest Management (IPM) or generalized "sustainable" practices, typically look at narrow endpoints, measured by toxicity and exposure for discrete effects, rather than the full range of critical life-sustaining interrelationships of species. Nearly three decades ago, a clearly defined form of agricultural land management was defined by Congress in the Organic Foods Production Act, creating a clear framework for evaluating practices in the context of biological and chemical interactions in the agroecosystem through a public oversight process. This is a tool that offers broad opportunity to effect a transformation in both agricultural and wider landscape management in communities. The importance of this tool, with required plans, allowed biodiversity-compatible materials, certification, and oversight, put actual practices into a framework of review to support continuous improvement, while rejecting generations of chemical-intensive practices that have depleted environmental resources and disrupted complex biological processes. It is the integrity of the organic law and programs in place to implement it that will determine whether we embrace biodiversity and a future that sustains life or let the future slip away.

Jay Feldman contributed to this article. A fully cited version of this article is available at bit.ly/pesticidesandyou.