Pesticide Impacts on Benefical Organisms

Our Forgotten Pollinators: Protecting the Birds and Bees

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A recent survey revealed that only a small percentage of the American public understands the process of pollination or the diversity of beneficial animals involved in pollinating plants.1 For most Americans, pollen means allergies and bees mean stings. However, for one out of every three bites you eat, you should thank a bee, butterfly, bat, bird or other pollinator.

Pollination -- the transfer of pollen from one flower to another -- is critical to fruit and seed production, and is often provided by insects and other animals on the hunt for nectar, pollen or other floral rewards. In fact, animals provide pollination services for over three-quarters of the staple crop plants that feed human kind and for 90% of all flowering plants in the world.

According to the U.S. Department of Agriculture (USDA), we are facing an "impending pollination crisis," in which both wild and managed pollinators are disappearing at alarming rates owing to habitat loss, pesticide poisoning, diseases and pests.2 For the first time ever, local bee shortages in 1994 forced many California almond growers to import the bulk of the honey bees they needed from other states to ensure that their $800-million-a-year crop would be pollinated. Recent monitoring of pumpkins in New York State determined that their blossoms were still laden with pollen five hours after they opened in the morning, long after they are typically stripped of all pollen by bees.3

Food producers and consumers, scientists and educators, beekeepers and wildlife enthusiasts who are concerned that a basic fact of life -- our dependence on the functional relationships between plants and pollinators -- is being

ignored have joined together to form the Forgotten Pollinators Campaign. The campaign seeks to heighten the public's awareness of the importance of pollinators and to urge action on the following points. Farms depend on pollinators

Insect pollination is a necessary step in the production of most fruits and vegetables that we eat and in regeneration of many forage crops used by livestock. Recent surveys document that more than 30 genera of animals -- consisting of hundreds of species of floral visitors -- are required to pollinate the 100 or so crops that feed the world.4 Only 15% of these crops are serviced by domestic honey bees, while at least 80% are pollinated by wild bees and other wildlife.

We must recognize that pollination is not a free service, and that investment and stewardship are required to protect and sustain it. Economic assessments of agricultural productivity should account for the "cost" of sustaining wild and managed pollinator populations. U.S. policymakers responsible for the recent cut in long-standing subsidies to beekeepers for honey production have further jeopardized the pollination services provided by honey bees, estimated to be 60 to 100 times more valuable than the market price of honey.5 Policy makers must begin devising programs that reward farmers for implementing practices to protect habitats of wild pollinators and provide incentives for those who wish to manage a wider variety of pollinators to assist farmers and orchard growers. A diversity of pollinators

Our recent analyses of global inventories of biodiversity indicate that more than 100,000 different animal species -- and perhaps as many as 200,000 -- play roles in pollinating the 250,000 kinds of wild flowering plants on this planet. In addition to countless bees (the world contains an estimated 40,000 species of bees), wasps, moths, butterflies, flies, beetles and other invertebrates, perhaps 1,500 species of vertebrates such as birds and mammals serve as pollinators. Hummingbirds are the best-known wildlife pollinators in the Americas, but perching birds, flying foxes, fruit bats, possums, lemurs and even a gecko function as effective pollinators elsewhere in the world. We must learn to appreciate the benefits that a diversity of pollinators provides.

Honey bees in decline

The number of commercial U.S. bee colonies plummeted from 5.9 million in the

late 1940s to 4.3 million in 1985, and 2.7 million in 1995. The loss of one quarter of all managed honey bee colonies since 1990 signals one of the most severe declines U.S. agriculture has ever experienced in such a short period. There are fewer bee hives in the U.S. today than at any time in the last 50 years.

This demise has been brought on by the spread of diseases and parasitic mites, invasion of Africanized honey bees, exposure to pesticides, climatic fluctuations and elimination of government subsidies for beekeepers.6 And an increasing number of places around the U.S. are reporting pollinator scarcity.7 Studies of cucurbit pollination in Arizona, Alabama and Maine revealed that honey bees are in fact frequently absent from fields, and that bumblebees and ground nesting squash bees are doing the majority of the pollination.8 In recent years, some wildland habitats have lost 70% of their feral honey bees, which make hives in rocky outcroppings and other cavities.9

The arrival of Africanized bees in 99 U.S. counties since 1990 has forced some beekeepers to abandon apiaries in highly populated areas for fear of libel suits from neighbors. In addition, Africanized bees are among the carriers of parasitic mites infect-ing thousands of U.S. apiaries, killing off additional colonies.10

To minimize further declines, honey bee colonies need better monitoring and management. Yet, USDA is currently considering closing bee research laboratories. Bee research must be strengthened and expanded to include research on management of pollinators other than honey bees. Increasingly, other pollinators will have to be deployed to take up the slack created by the decline of honey-bee colonies. Orchard growers and farmers need to ensure that neighboring wild habitats remain suitable for wild pollinators if they are to secure pollination services for their crops.

For such reasons, government agencies such as the USDA, SARH/Mexico and Agriculture Canada should invest more resources in programs to manage a diversity of pollinators, to stabilize remaining apiaries, and to reward farmers for setting aside cropland and retaining hedgerows or windbreaks where wild pollinators nest and forage.

Protection from toxins

Whether managed or wild, pollinators need protection from excessive exposure

to pesticides and other chemicals that can poison them or impair their reproduction. These chemicals can also eliminate nectar sources for pollinators, destroy larval host plants for moths and butterflies, and deplete nesting materials for bees.11

Few people realize that the U.S. now applies twice the amount of pesticides it used when Rachel Carson published Silent Spring in 1962.12 In Canada during the mid-1970s, aerial spraying of coniferous forest pests reduced native bee populations to the point that blueberry yields fell below the norm for four years.13

A large number of insecticides used in agriculture are toxic to pollinating insects, but only honey bee colonies can be moved away from fields prior to spraying. Even so, it has been estimated that 20% of all losses of honey-bee colonies involve some degree of pesticide exposure. According to a study on economic costs of pesticide use, honey bee poisonings result in an annual loss of $13.3 million in the U.S.14 Wild insect pollinators such as small solitary bees are even more vulnerable than honey bees to organophosphate pesticides that have largely replaced organochlorines like DDT. Field studies in the deserts of the U.S. have found that pollinators remaining in small fragments of natural habitat are particularly susceptible to insecticide spraying on adjacent croplands.15

Moreover, many crops that would benefit in quality and quantity from more thorough pollination are not sufficiently pollinated because of heavy pesticide applications. Cotton harvests, for example, could increase by as much as 20% if the flowers were fully pollinated by bees, and farm income could potentially increase by US$400 million per year. However, using bees to enhance cotton has proven impossible on a large scale where there has been continued intensive use of insecticides.16

Pesticide applicators need training in monitoring pollinators as well as pests. Pollination ecologists familiar with particular species can work with pesticide applicators who know about timing and the drift distances of chemicals under various weather conditions.17 When pesticides are applied by aircraft, as much as 50% to 75% of the chemicals sprayed can miss their target,18 leading to inadvertent exposure of nontarget organisms such as pollinators.

Alternative agricultural techniques can provide non-toxic methods of weed and

insect control that incorporate use of habitat set-asides for beneficial insect populations and require the use of fewer toxins. Alternative strategies may help farmers reduce costs involved in crop management, and at the same time allow them to market organic produce at premium prices.

Both gardeners and farmers can rely on alternative non-toxic methods to control pests and weeds. More widespread practice of such methods has the potential to reduce wildlife exposure to insecticides, herbicides and fungicides.19 Urban dwellers can also reduce the amounts of toxins used around their homes, and by purchasing organic produce, they can provide economic incentives for growers to switch to more pollinator- friendly organic methods.

Habitat loss -- a major threat

Small isolated patches of wild habitat may look natural and healthy, but they often lack essential pollinators and seed dispersers that ensure regeneration of the biotic community.20 These animals typically require more habitat area than that covered by populations of the rarest plants. When large habitats are fragmented into small isolated patches, it is not long before some of the animal residents decline in numbers to the point that they no longer provide effective ecological services beneficial to plants.21 Globally, over 100 species of birds and mammals in sixty genera of vertebrate pollinators are already listed as endangered, and untold numbers of invertebrates are at risk as well.

Because some wild pollinators need undisturbed habitat for nesting, roosting and foraging, they are very susceptible to habitat degradation and fragmentation. Some pollinators require plants that flower sequentially, so that they have food sources throughout the season. Elimination of these sources by herbicide spraying or clearing of native vegetation can literally starve pollinators. In Costa Rica, wild bee diversity in degraded forest land dropped from 70 to 37 species in just 14 years. Population declines have also been confirmed for butterflies, moths, flying foxes and a host of other pollinators of food crops.22

We must find ways to reward farmers for setting aside land to support wild pollinators. Unplowed farmland set aside for several years can produce vegetation that supports considerable insect diversity and benefits nearby crops by providing pollinators and other beneficial insects.23 Land use planners should work to create semi-natural buffers around small wildlife reserves to

connect protected areas with undeveloped corridors and to designate pesticide-free zones within this matrix. Greenbelts and habitat set-asides need not always consist of pristine vegetation, but they must be large enough to provide safe nesting sites and a range of floral resources.

Endangered pollinators -- endangered plants.

In the larger picture, native pollinators are as important for wild plants as they are for crops. Yet the ultimate reproductive consequences of pollinator scarcity on wild plants is not appreciated and remains understudied.24

In Iowa, where only 200 acres of unplowed "virgin" prairie remain intact, prairie wildflowers now suffer low seed yields for lack of adequate visitation rates by pollinators.25 Rare cacti in national parks and adjacent to heavily sprayed cotton fields also suffer high levels of floral abortion due to a paucity of moths.26 There are small nature reserves nested within urban areas that contain rare plants, but their flowers wither without producing fruit. In one small reserve within urban Tokyo, for example, a primrose almost completely fails to set seed, owing to local disappearance of its bumblebee pollinator.27

The last remaining natural populations of a rare evening primrose live in California's Antioch Dunes National Wildlife Refuge. Though the primrose is protected, its hawkmoth pollinator has not reappeared after years of pesticide spraying in nearby vineyards, and reproduction of the plant has remained low.28 The primrose remains in jeopardy as it produces few fruits and low percentages of viable seeds, while its weedy neighbors produce many. This is just one of many examples where pesticide use, decrease of nectar sources or larval host plants, and other threats have triggered the decline of pollinators of endangered plants.

Unfortunately, not even federally listed endangered plants are regularly monitored for pollinator availability. A survey of federal recovery plans for sixteen endangered plants growing near the U. S./Mexico border revealed that the range of available pollinators had been determined for only two of them, and threats to pollinators themselves had not been taken into account at all.

Because of such "reciprocities," conservation policy and practice should move toward sustaining or restoring ecological relationships, rather than treating species as isolated organisms. "Critical habitat" needs to be redefined to include

needs of both rare plants and their animal associates. When critical habitat has been designated for endangered plants, it has almost always been done without determining foraging and nesting areas required to ensure sufficient pollinators and seed dispersers for long-term recovery of the plant in danger. To begin to resolve some of these discrepancies, the Forgotten Pollinators Campaign is currently working with entomologists and conservation biologists to create pollinator monitoring protocols that can be used by land managers around the country. Migratory pollinators require protection

Bats, hummingbirds, moths and butterflies are among the pollinators that seasonally migrate long and short distances between mountain ranges, regions and countries. Their migratory routes are often well-defined "nectar corridors" where the sequence of flowering over a season offers pollinators sufficient energy to sustain their journey. Many of these nectar corridors are no longer fully intact, however; land conversion has eliminated some floral resources over 20 to 60 mile segments, in some cases longer than the distance energy-depleted pollinators can fly in one day.29

Scientists and policy makers need to collaborate across political boundaries and regions to assess the continuity and health of migratory corridors used by pollinators. Because some migrants travel 2,000 to 4,000 miles a year, habitat loss in one area of their range may limit their populations overall. Certain migratory pollinator species aggregate in large numbers in temporary roosts that are vulnerable to human disturbance. Such roost sites should be protected throughout a species' entire range since a refuge in just one portion will be insufficient to support a viable population. International policy agreements and environmental education efforts are needed to champion migratory pollinators.

A threatened ecological service

Interactions between plants and their pollinators are essential to healthy functioning of wild and agricultural communities. Habitat loss, disease, and pesticides take their toll in different ways, but all imperil these vital ecological relationships, many of which developed through thousands of years of natural and cultural selection.

Three-quarters of the 100 or so crop species that feed the world depend on animals as go-betweens to ensure that crops are pollinated. Crises like those now faced by the honey-bee industry demonstrate that we lack safety nets to

protect agricultural yields. We can no longer justify devoting all research and management dollars to a single or even a few pollinators, but instead must support a diversification of the entire pollination industry.

As a society, we need to recognize our debt to the "forgotten pollinators." To successfully confront the impending pollinator crisis, we must work together. Foresters, entomologists and conservationists must devise workable plans for endangered plant species that include pollinators. Farmers, orchard growers, and other land managers need to consider pollinators as they make decisions about pesticides and land use. Educators must emphasize the importance of pollinators in wild and agricultural lands and the interconnectedness of life in general.

Urban dwellers can purchase organic produce, include nectar and host plants for pollinators in their gardens, and rely on organic methods of pest and weed control. Pollinator gardening provides hummingbirds, butterflies and other wildlife with important sources of nectar as well as increasing our awareness of the diversity of ecological relationships in our own backyards.

In an era when human activities place increasing pressure on both natural and rural landscapes, we cannot ignore the vital role of pollination services and the frequently negative impacts that we are having on plant/pollinator relationships

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- Some pesticides highly toxic to bees
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dieldrin
dimethoate
endosulfan
EPN
fenitrothion
fenthion
heptachlor
malathion
methomyl
mevinphos
monocrotophos
parathion
pirimiphos-ethyl
phosmet
Sources: Basic Guide to Pesticides, Shirley Briggs, 1992.
Farm Chemicals Handbook, Meister Publishing Co., 1996.

References

1 National zoo 1994

2 USDA-ARS, 1991, Pollination Workshop Proceedings, unpublished, Denver, CO.

3 Watanabe, M.E., 1994, Pollination worries rise as honey bees decline, Science 265:1170.

4 Prescott-Allen, R. and C. Prescott-Allen, 1990, How many crops feed the world?

Conservation Biology 4(4): 365-374. Buchmann, S.L. and G.P. Nabhan, 1996, The Forgotten Pollinators, Island Press, Washington, D.C.

5 McGregor, S.E. 1976, Insect Pollination of Cultivated Crop Plants, USDA Agriculture Handbook 496, USDA, Washington, D.C. Southwick, E.E., and L. Southwick, Jr., 1992, Estimating the economic value of honey bees (Hymenoptera Apidae) as agricultural pollinators in the United States, Economic Entolmology 85(3):621-633.

6 USDA-ARS, 1991, Pollination Workshop Proceedings, unpublished, Denver, Co.

7 Burd, M., 1994, Bateman's principle and plant reproduction: the role of pollen limitation in fruit and seed set, Botanical Review 60:81-109. Watanabe, M.E., 1994, Pollination worries rise as honey bees decline, Science 265:1170.

8 The Forgotten Pollinators Campaign, October 1996.

9 Loper, G.M., 1995, A documented loss of feral bees due to mite infestations in Southern Arizona, American Bee Journal, December: 823.

10 Hoff, F.L. and L.S. Willert, 1993, The U.S. Beekeeping Industry, USDA, Washington, D.C.

11 Nabhan, G.P. and S.L. Buchmann, 1996 (in press), Pollination services: biodiversity's direct link to world food stability, in G. Daly, ed. Ecosystem Services, Island Press, Washington, D.C.

12 Carson, R., 1962, Silent Spring, Houghton-Mifflin, New York. Curtis, J. and T. Profeta, 1993, After Silent Spring, Natural Resources Defense Council, NY.

13 Kevan, P.G., 1975, Pollination and environmental conservation, Environmental Conservation, 2(4): 293-298.

14 Pimentel, D., H. Acquay, M. Biltonen, P. Rice, M. Silva, J. Nelson, V. Lipner, S. Giordano, A. Horowitz, and M. D'Arnore, 1992, Environmental and economic costs of pesticide use, BioScience 42(10):750-760.

15 Suzan, H., G. P. Nabhan and D. T. Patten, 1994, Nurse plant and floral biology of a rare night-blooming cereus, Peniocereus striatus (Brandegee) Buxbaum, Conservation Biology, 8:461-470.

16 Pimentel, D., H. Acquay, M. BiltDnen, P. Rice, M. Silva, J. Nelson, V. Lipner, S. Giordano, A. Horowitz, and M. D'Arnore, 1992,Environmental and economic costs of pesticide use, BioScience 42(10):750-760.

17 Holmbert, M., 1993, Get the drift? Not! Successful Farming, May/June, 39-40.

18 Pimentel, D., H. Acquay, M. BiltDnen, P. Rice, M. Silva, J. Nelson, V. Lipner, S. Giordano, A. Horowitz, and M. D'Arnore, 1992, Environmental and economic costs of pesticide use, BioScience 42(10):750-760.

19 Colborn, T., S. Dumanowski and J. P. Myers, 1996, Our Stolen Future. Dutton, New York.

20 Hendrix, S. D., 1994, Effects of population size on fertilzation, seed production, and seed predation in two prairie legumes,

North American Prairie Conference Proceedings 13: 115-119. Nabhan, G. P. and S. L. Buchmann, 1996 (in press), Pollination services: biodiversity's direct link to world food stability, in G. Daly, ed., Ecosystem Services, Island Press, Washington, D.C.

21 Hendrix, S.D., 1994, Effects of population size on fertilzation, seed production, and seed predation in two prairie legumes, North American Prairie Conference Proceedings 13: 115-119.

22 Buchmann, S.L. and G.P. Nabhan, 1996, The Forgotten Pollinators, Island Press, Washington, D.C.

23 Corbet, S.A., 1995, Insects, plants and succession: advantages of long-term set-aside, Agriculture Ecosystems & Environment 53:201-217.

24 Nabhan, G.P. and T. Fleming, 1993, The conservation of mutualisms, Conservation Biology, 7(3): 457-459.

25 Hendrix, S.D., 1994, Effects of population size on fertilization, seed production, and seed predation in two prairie legumes, North American Prairie Conference Proceedings 13: 115-119.

26 Suzan, H., G.P. Nabhan and D.T. Patten, 1994, Nurse plant and floral biology of a rare night-blooming cereus, Peniocereus striatus (Brandegee) Buxbaum, Conservation Biology, 8:461-470.

27 Washitani, I., R. Osawa, H. Namai, and M. Niwa, 1994, Patterns of female fertility in heterostylotis Primula seiboldii under severe pollinator limitation, Journal of Ecology, 82:571-579.

28 Pavlik B.M., N. Ferguson, and M. Nelson, 1993, Assessing limitations on growth of endangered plant populations, Biological Conservation, 65: 267-278.
29 Nabhan, G.P. and T. Fleming, 1993, The conservation of mutualisms, Conservation Biology, 7(3): 457-459.

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