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A bumblebee (*Bombus terrestris*) collecting pollen from a blueberry flower. Unregulated trade in bumblebees puts them outside their native range.

BIODIVERSITY

Ten policies for pollinators

What governments can do to safeguard pollination services

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Earlier this year, the first global thematic assessment from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) evaluated the state of knowledge about pollinators and pollination (*1*, *2*). It confirmed evidence of large-scale wild pollinator declines in northwest Europe and North America and identified data shortfalls and an urgent need for monitoring elsewhere in the world. With high-level political commitments to support pollinators in the United States (*3*), the United Kingdom (*4*), and France (*5*); encouragement from the Convention on Biological Diversity's (CBD's) scientific advice body (*6*); and the issue on the agenda for next month's Conference of the Parties to the CBD, we see a chance for global-scale policy change. We extend beyond the IPBES report, which we helped to write, and suggest 10 policies that governments should seriously consider to protect pollinators and secure pollination services. Our suggestions are not the only available responses but are those we consider most likely to succeed, because of synergy with international policy objectives and strategies or formulation of international policy creating opportunities for change. We make these suggestions as independent scientists and not on behalf of IPBES.

RISK REDUCTION

Pesticides are the most heavily regulated of the interacting drivers of pollinator declines (*7*). Risk assessment and use regulation can reduce pesticide hazards at national scales (*2*), yet such regulation is uneven globally. Many countries do not have national pesticide regulation and control systems or adhere to the International Code of Conduct on Pesticide Management (ICCPM), recently updated by the United Nations (*8*, *9*). International pressure to raise pesticide regulatory standards across the world should be a priority. This includes consideration of sublethal and indirect effects in risk assessment and evaluating risks to a range of pollinator species, not just the honey bee, *Apis mellifera*.

Another priority is to capitalize on the profile of integrated pest management (IPM) in international policies, such as the ICCPM (*9*) and the European Union's (EU's) Sustainable Use of Pesticides Directive (*10*). IPM combines pest monitoring with a range of pest control methods, such as crop rotation, field margin management, and biological control; pesticides are used as a last resort, only when other strategies are insufficient (*11*). IPM can decrease pesticide use and reduces risks to nontarget organisms, so it should be linked to pollinator health and pollination.

Genetically modified (GM) crops pose potential risks to pollinators through poorly understood sublethal and indirect effects (*1*). For example, GM herbicide-tolerant crops lead to increased herbicide use, reducing the availability of flowers in the landscape, but consequences for pollinators are unknown. GM crop risk assessments in most countries do not capture these effects. They evaluate only direct effects of acute exposure to proteins expressed in the GM plants, usually in terms of the dose that kills 50% of adults (LD_{50}), and only for honey bees, not other pollinators. International guidance to improve GM organism risk assessment is being developed under the CBD's Cartagena Protocol on Biosafety (*12*); this presents an opportunity to encourage inclusion of indirect and sublethal effects on a range of pollinator species.

There are substantial risks from movement of managed pollinators around the world (*1*). Managed pollinators, including newly domesticated species, offer opportunities to grow businesses and improve pollination services. Commercial bumble bee trade has grown dramatically, leading to invasions of *Bombus terrestris* beyond its native range and increasing the risk of disease transfer to native wild bee populations, potentially including other bee species (*13*). The issue of invasive species has been highlighted in the UN Sustainable Development Goals and the CBD's Strategic Plan for Biodiversity, which parties to the CBD are implementing in national strategies and action plans. This creates momentum and opportunity for regulators to consider limiting and better managing pollinator movement within and between countries.

SUSTAINABLE FARMING

Agriculture is a major driver of pollinator declines, through land-use change; intensive practices, such as tillage and agrochemical use; and declines in traditional farming practices. Agriculture also provides opportunities to support wild pollinators (*1*). We propose two complementary policy objectives: (i) promote ecological intensification of agriculture (*14*) and (ii)

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support diversified farming systems (*15*).

Ecological intensification involves managing ecological functions, such as pollination and natural pest regulation, as part of highly productive agriculture. It can be as profitable and productive as conventional approaches at a farm level, even with up to 8% of land out of production to provide habitats that support beneficial organisms (*16*).

A major barrier to uptake of ecological intensification is uncertainty about ecological and agronomic outcomes. To tackle uncertainty, a promising option is to adjust crop insurance schemes to provide incentives, such as lower premiums or smaller loss thresholds, for farmers who take action to promote pollinators. Insurance is a key element in "climate-smart agriculture" (*17*) but has yet to be tested or adopted for more general agricultural sustainability.

Another barrier, lack of knowledge among farmers and agronomists, can be addressed by extension services. For example, national Farm Advisory Systems are obligatory for member states under the EU's Common Agricultural Policy. The extent to which these provide information relevant to ecological management could be improved.

Diversified farming systems (including some organic farms, home gardens, agroforestry, mixed cropping, and livestock systems) incorporate many pollinator-friendly practices, such as flowering hedgerows, habitat patchiness, and intercropping (*1*). Support for these systems can be achieved through financial incentives, such as European agri-environment schemes (*18*), or market-based instruments, such as certification schemes with a price premium—both used to support organic farming. In at least 60 countries, these practices and farming systems depend on indigenous and local knowledge (*2*). To secure people's ability to pursue pollinator-friendly practices, their tenures and rights to determine their agriculture policies (food sovereignty) must be recognized and strengthened (*19*).

Ten pollinator policies

1. Raise pesticide regulatory standards.
2. Promote integrated pest management (IPM).
3. Include indirect and sublethal effects in GM crop risk assessments.
4. Regulate movement of managed pollinators.
5. Develop incentives, such as insurance schemes, to help farmers benefit from ecosystem services instead of agrochemicals.
6. Recognize pollination as an agricultural input in extension services.
7. Support diversified farming systems.
8. Conserve and restore "green infrastructure" (a network of habitats that pollinators can move between) in agricultural and urban landscapes.
9. Develop long-term monitoring of pollinators and pollination.
10. Fund participatory research on improving yields in organic, diversified, and ecologically intensified farming.

BIODIVERSITY AND ECOSYSTEM SERVICES

Policy interest in pollinators stems largely from their role in food production (*2*). Historically, the most widely adopted policy approaches for biodiversity conservation have been to identify and protect threatened species and to create protected areas. These remain critical but are not sufficient to maintain the substantial global value of pollination services in agriculture, for two reasons. First, the spatial separations between protected areas, as well as between protected areas and croplands, are usually large relative to daily movements of most pollinators. Second, although pollinator diversity is important, the bulk of crop pollination is from relatively few common, widespread species rather than rare or threatened species (*20*). For crop pollination, the policy goal should be to secure a minimum level of appropriate habitat, with flower and nesting resources, distributed throughout productive landscapes at scales that individual pollinators can move between. This fits the definition of "green infrastructure" identified by the EU in 2013 (*21*). It involves a diverse range of land managers, with overview and coordination at regional scales. As examples, small patches of habitat on public lands might be conserved through regulation, whereas protection or restoration of habitat on private land might be achieved through incentive payments (*18*) or by encouraging voluntary action (*22*). To conserve wider pollinator diversity and functions not relevant to agriculture, this approach must be integrated within strategically planned habitat and species protection policies (*20*, *23*).

INCREASING KNOWLEDGE

There are substantial knowledge gaps about the status of pollinators worldwide and the effectiveness of measures to protect them (*1*). Evidence is largely limited to local-scale, short-term effects and is biased toward Europe and North America. There is a need for long-term, widespread monitoring of pollinators and pollination services. Recent research funded by the U.K. government as part of the National Pollinator Strategy for England (*4*) compared ways to achieve this monitoring, with varying levels of professional and volunteer involvement (*24*).

Finally, we suggest funding research on how to improve agricultural yields in farming systems known to support pollinators. This underpins several policies in our list. It also resonates with a global focus on improving food production and food security, especially on small farms (<2 ha), which represent more than 80% of farms and farmers, and 8 to 16% of farmed land (*2, 25*). To ensure that findings are considered credible, salient, and legitimate by agricultural communities, the research should prioritize knowledge co-production and exchange between scientists, farmers, stakeholders, and policy-makers. Such approaches can be supported through national and international research funding or institutional infrastructure. ■

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