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POLICY ANALYSIS PAPER: POLICY MAINSTREAMING OF BIODIVERSITY AND ECOSYSTEM SERVICES WITH A FOCUS ON POLLINATION

POLLINATION SERVICES FOR SUSTAINABLE AGRICULTURE

POLICY ANALYSIS PAPER: POLICY MAINSTREAMING OF BIODIVERSITY AND ECOSYSTEM SERVICES WITH A FOCUS ON POLLINATION

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This publication considers the mainstreaming of ecosystem services at both national and international levels, with a focus on pollination services. Following work undertaken through the GEF/UNEP/FAO Global Pollination Project, and through funding from the Norwegian Environment Agency, this publication addresses the interface between science and policy as a contribution to the work of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).

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Students in the pollinator garden designed to do counts for the Great Sunflower Project at Peralta Elementary School in Oakland, California.

PREFACE

Ecosystem services that sustain agricultural productivity, such as pollination and natural pest control, are central to FAO's strategic goal of "sustainable management and utilization of natural resources, including land, water, air, climate and genetic resources for the benefit of present and future generations".

The role and importance of ecosystem services has risen to the attention of policymakers globally, through the Millennium Ecosystem Assessment that was carried out several years ago. In addition to being a much-researched scientific topic, ecosystem services have been taken up in the focal areas of a number of international initiatives and fora, including the Convention on Biological Diversity's Aichi Biodiversity Targets, the current draft proposal for Sustainable Development Goals and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (lPBES).

Yet the divide between science, knowledge and policy is still wide; while ecosystem services are recognised in policy documents and in the scientific literature, there is a lack of clear and specific guidance on how their effective functioning can be supported through policy measures. The knowledge of local communities on the importance of ecosystem services is often profound and intimately tied up with their livelihoods and wellbeing, yet again the interfaces with both policy and science are poorly articulated.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (lPBES) is intended to strengthen the interface between the scientific community, knowledge-holders and policymakers, and build capacity for and strengthen the use of science and knowledge in policymaking. It has taken, as the focus of its early deliverables, a "thematic assessment of pollinators, pollination and food production". FAO, in its role as coordinator and facilitator of the International Pollinator Initiative, has been working with a large number of countries in assembling a stronger knowledge base on pollination services and measures to conserve and sustainably use pollinators in sustainable agriculture. In one specific focal area, FAO developed a protocol to identify and assess pollination deficits in crops. Through the support of the Global Environment Facility (GEF), the United Nations Environment Programme (UNEP) and the Norwegian Environment Agency, partners in eleven countries and indigenous communities in southern India have been trained and supported to apply the protocol to pollinator-dependent crops. A global meta-analysis is emerging from this endeavour, with strong indications that pollination deficits may exist in a wide variety of farming systems across the world.

These scientific findings require action. At a workshop convened in Naro Moru, Kenya (September 2013), researchers and policymakers from the eleven countries considered the range and types of actions that can address pollination deficits, and developed an indicative set of policy responses. FAO has subsequently worked with its partners and with the Berkeley Food Institute to elaborate on the scope of these proposed policy responses, to safeguard ecosystem services such as pollination that underpin resilient agricultural systems. It is our hope that this document will be a first step to close the gap between science, knowledge-holders and both environmental and agricultural policy-makers.

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Bee signs designed and built by students (Great Sunflower Project, Peralta Elementary School, Oakland California).

EXECUTIVE SUMMARY

- Biodiversity and ecosystems are critical to human well-being and agricultural production, and are under increasing threat.
- In the last decade, the science on the valuation of ecosystem services has progressed rapidly and numerous entities have developed best practices protocols in an effort to reverse the trend of degradation. However, many governments still need to take steps to integrate these efforts into decision and policy-making.
- Pollination services, being relatively well understood, can serve as a case study to promote a broader agenda for protecting ecosystem services. Pollination is typical of many ecosystem services, which are "provided" by small and often inconspicuous organisms (e.g. natural pest control, soil nutrient cycling) that have not received sufficient attention within policy environments.
- Concerted efforts towards awareness raising and mainstreaming must take place. Mainstreaming implies ensuring that the positive or negative impacts of policies on ecosystems and their services are considered during both the policy design and the policy implementation phase, as well as ensuring the existence of policies tailored to the promotion of ecosystem services.
- Researchers have outlined a useful model for mainstreaming ecosystem services based on socially relevant, user-inspired research, stakeholder empowerment and adaptive management. While the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) process forms part of the overall assessment process, it should take into consideration the tools required by policy-makers for successful planning and management. Importantly, mainstreaming is more likely to succeed if users of ecosystem services are engaged early in the policy development process.
- Concrete examples of targeted and effective approaches exist for conserving pollinator and pollination services, and policy-makers should take these approaches into consideration.
- Key thematic areas of successful approaches which decision-makers can support include:
    - Pollinator-friendly pesticide policies;
    - Conservation and enhancement of pollinator habitats;
    - Valuation, incentives and payments for ecosystem services;
    - Participation, knowledge-sharing, and empowerment of rural and indigenous peoples and local communities;
    - Collaborative research and outreach; and
    - Public awareness raising and knowledge sharing.

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Top: Vegetable market, Mankessim, Ghana; below: leaf cutter bee approaching sun hemp flower, Turkana, Kenya

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SECTION 1 INTRODUCTION

1.1 ECOSYSTEMS ARE ESSENTIAL FOR HUMAN LIFE

Ecosystems provide numerous physical goods such as food and timber that contribute to the quality of life and constitute essential inputs to local and global economies. In addition to these tangible goods, ecosystems provide less visible processes, such as water purification, soil formation and pollination, that are also necessary to support human life but are less likely to be acknowledged for their importance (MEA, 2005b). These goods and processes obtained from ecosystems are known collectively as *ecosystem services* and are generally categorized into four types depending on their function: provisioning, regulating, habitat, and cultural and amenity services (TEEB, 2010). Box 1 provides an explanation of these categories and offers additional examples.

Box 1

SUMMARY OF KEY DEFINITIONS

An ecosystem, as defined in the Convention on Biological Diversity (CBD), is "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit".

Ecosystem services are "the benefits obtained from ecosystems" and are generally categorized as:

- ***Provisioning services*: the products derived from ecosystems (e.g. food, water, timber, fibre);**
- ***Regulating services*: the benefits derived from ecosystem processes (e.g. regulation of climate, floods, diseases, wastes, water quality, pollination, soil formation);**
- ***Habitat services*: ecosystems provide habitats for plants and animals; certain services (e.g. maintenance of genetic diversity, maintenance of life cycles of migratory species) depend on the condition of the habitat; and**
- ***Cultural and amenity services*: non-material benefits from ecosystems (e.g. recreation, aesthetic enjoyment, spiritual fulfilment, scientific knowledge) (TEEB, 2010).**

Biological diversity, or biodiversity, is defined in the CBD as "the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part".

Agricultural biodiversity, or agrobiodiversity, "includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute agricultural ecosystems" (CBD, COP decision V/5).

Agricultural extensification refers to the increase in areal extent of agriculture (Foley *et al.*, 2011; Power, 2010), whereas agricultural intensification indicates the increase in production on the same land footprint (Foley *et al.*, 2011; Diaz and Rosenberg, 2008; Tilman *et al.*, 2002).

Agroecology is a broad term that involves "the application of ecological concepts and principles to the design and management of sustainable agro-ecosystems" (Altieri, 1995). An agroecosystem is "a site or integrated region of agricultural production – a farm, for example – understood as an ecosystem" (Gliessman, 2006). Agroecology is not only a scientific discipline but also a practice with a guiding set of principles and methods utilized by farmers, as well as a movement that seeks to rethink the interaction of agriculture, people and the environment (Gliessman, 2006; Wezel *et al.*, 2009).

Underpinning the concept of ecosystem services is the idea that the value of an ecosystem is greater than the sum of its parts, and that certain benefits are the result of the interactions of different components of the system. For example, healthy and highly functioning ecosystems are often more resilient and can recover more quickly when faced with disturbances such as flooding. Correspondingly, highly modified or simplified ecosystems, such as agricultural regions experiencing extensive deforestation, are often prone to greater risk and severity of flooding (Bradshaw *et al.*, 2007). Thus, in addition to conserving tangible natural resources, attention must be paid to the ecological processes that also provide essential services. Box 2 provides further details of the interrelations between ecosystem services and agriculture.

Box 2

ECOSYSTEM SERVICES AND AGRICULTURE

Agriculture is the world's largest managed ecosystem accounting for approximately 50 percent of the terrestrial land surface (Foley *et al.*, 2005). Agriculture not only relies on critical ecosystem services such as pollination, pest control and soil fertility to produce provisioning services (e.g. food, fibre and fuel), but can also contribute to regulating ecosystem services such as carbon sequestration and water purification. Thus, ecosystem services flow both to and from agriculture (Figure 1).

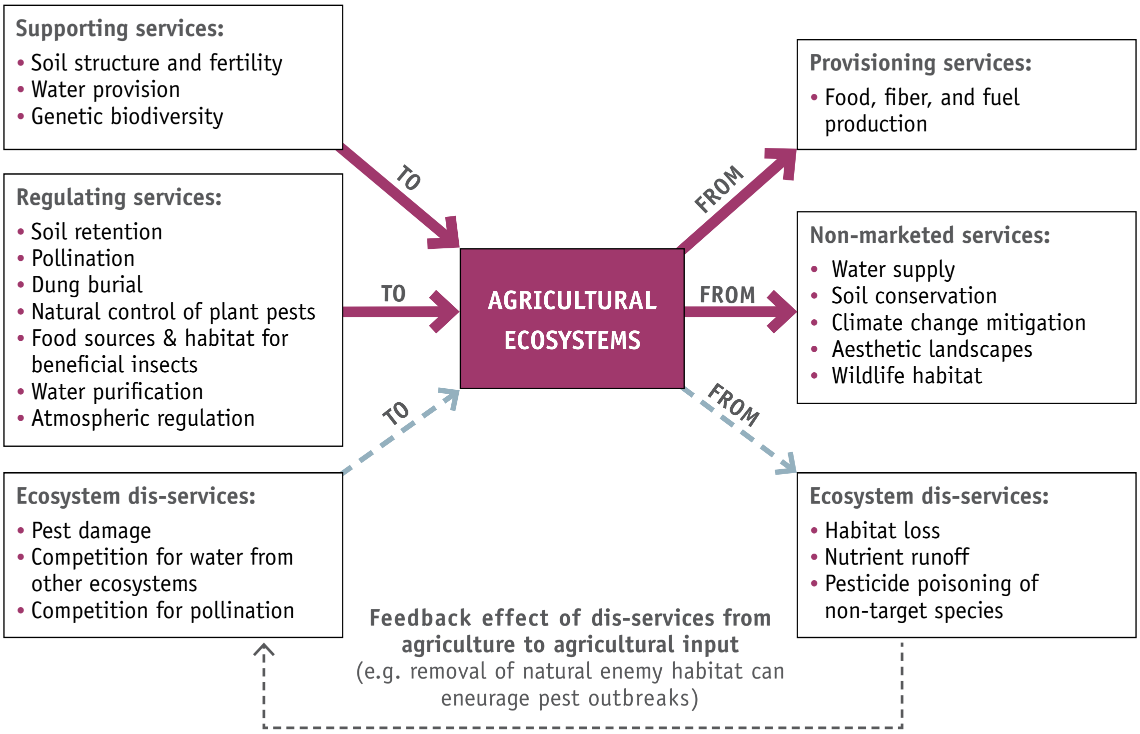
In turn, agriculture affects and is affected by ecosystem "disservices". For example, pests may invade agricultural fields from nearby semi-natural habitats, constituting an ecosystem "disservice". Agricultural management practices may lead to ecosystem disservices both on the farm (e.g. use of pesticides that harm pollinators) and off the farm (e.g. nitrate and phosphate pollution and the accumulation of toxic pesticides). The latter impacts are also known as "negative externalities", generally defined as negative impacts on society that are not accounted for by the producer or consumer of the goods.

The balance of services to disservices produced by agriculture depends on the way in which agricultural lands are managed. Agroecological methods are sometimes considered to produce fewer provisioning services (e.g. lower crop yield), but higher levels of regulating services (e.g. better water quality, soil fertility) and fewer externalities (Foley *et al.*, 2005). However, there is some evidence to suggest that agroecological methods can produce similar or higher yields in certain cases, while still generating multiple ecosystem goods and services (FAO, 2014; Midler *et al.*, 2012; Pretty *et al.*, 2006). Industrialized, chemical-based agriculture often replaces ecosystem service inputs with external, purchased inputs such as pesticides, fertilizers and managed honey bees. While such systems often produce high yields, they produce few regulating services and many negative externalities (Foley *et al.*, 2011; Kremen and Miles, 2012; Raudsepp-Hearne *et al.*, 2010). Additional investment in developing agroecological methods, which have historically been underfunded relative to conventional agriculture (Carlisle and Miles, 2013), could potentially close yield gaps between agroecological and conventional agriculture.

The larger landscape in which agriculture is embedded produces ecosystem services and disservices that affect agroecosystems. For example, nearby natural habitats can export both beneficial insects such as natural enemies and pollinators onto crop fields, as well as pest organisms. In turn, agriculture also affects the larger landscape. For example, agriculture that supports native pollinators might also contribute pollinators to the reproduction of non-crop plants in adjacent natural habitats. Conversely, agricultural waste products, such as nitrate and phosphate runoff or pesticides, can adversely affect the health of surrounding landscapes and peoples (Kremen and Miles, 2012).

Figure 1

FLOWS OF ECOSYSTEM SERVICES AND DISSERVICES TO AND FROM AGRICULTURE



Source: Zhang *et al.*, 2007.

1.2 POLLINATION IS A KEYSTONE ECOSYSTEM SERVICE

Pollination, the process of moving pollen from the male anther to the female stigma within the same flower or in another flower, is an example of a keystone ecosystem service that is critical for agricultural productivity, as well as the promotion of broader diversity and ecosystems. The process is sometimes also referred to as "pollination services" and for the purposes of this paper the two terms are used interchangeably. Eighty-six percent of all flowering plant species require an animal pollinator to reproduce (Ollerton, Winfree and Tarrant, 2011). About one-third of food production depends on animal pollinators, and 75 percent of all fruits and vegetables increase production when visited by animals (Klein *et al.*, 2007). And yet, as is typical of many ecosystem services that are provided by small and often inconspicuous organisms, pollination services have not yet received adequate recognition within many policy environments. However, several programmes and policies related to the conservation and promotion of pollinators have achieved success. Thus, pollination services can serve as a case study for the promotion of ecosystem services through public policy. Accordingly, this report outlines several key considerations for mainstreaming and suggests specific policy responses to pollinator and pollination service declines (Kremen and Miles, 2012; Lin, 2011; Thompson *et al.*, 2011).

1.3 BIODIVERSITY IS IMPORTANT FOR THE PROVISION OF ECOSYSTEM SERVICES

Biological diversity, or biodiversity, is a broad term that describes the variety of life on Earth – from tiny microorganisms to plants and animals, and from genes to ecosystems. Diversity of life is a critically important component of the healthy, functioning ecosystems upon which human life and well-being depend (MEA, 2005a). In the context of farms and ranches, agricultural biodiversity (or agrobiodiversity) refers to the diversity of life within the farming system, ranging from soil microorganisms to the diversity of genetic resources, crops, insects and other species that are needed for production. The term also includes diversity in surrounding landscapes and ecosystems that influence agriculture (http://www.cbd.int/agro/whatis.shtml).

1.4 GLOBAL DECLINES IN BIODIVERSITY AND ECOSYSTEM SERVICES

Despite their importance to human well-being, biodiversity and ecosystem services face increasing threats worldwide, with consequent negative impacts on human quality of life. The Millennium Ecosystem Assessment, conducted in 2005, estimates that 60 percent of ecosystem services are being degraded or not being regenerated quickly enough to meet demand. Pollination, the focus of this report, was identified as an example of an ecosystem service whose capacity is currently being degraded due to the global decline in pollinator abundance (MEA, 2005b). Section 2.3 provides an explanation of current trends.

1.5 NEGATIVE IMPACTS OF ECOSYSTEM DECLINES ON AGRICULTURE, FOOD SECURITY AND NUTRITION

The global trend towards biodiversity and ecosystem service loss is especially concerning with regard to agriculture, since agricultural productivity is reliant upon a multitude of these often-invisible ecosystem services (Foley *et al.*, 2005; Kremen and Miles, 2012; Zhang *et al.*, 2007). The degradation of ecosystem services necessary for agriculture, coupled with the likely increase in demand for food and continual inequities in food systems with regard to land and food distribution, could limit the world's ability to move towards global food security and meet nutritional requirements for the world's population (Tomlinson, 2013).

1.6 IMPLICATIONS AND CAUSES OF ECOSYSTEM DECLINE

The causes of ecosystem service decline vary depending on the individual service and by region, but common drivers of ecosystem change include climate change, land conversion, pollution, over-exploitation, and invasive species and disease (Nelson, 2005). Despite the reliance of agriculture on ecosystem services, many agricultural and land management practices are contributing to broader ecosystem service decline. For example, worldwide agricultural *extensification* (the increase in areal extent of agriculture) has resulted in the conversion of forests and grasslands to agricultural lands, reducing the land available for wildlife habitats including for pollinators (Foley *et al.*, 2011; Power, 2010). Furthermore, some forms of agricultural *intensification* (increase in production for the same land footprint), have resulted in multiple negative externalities that reduce biodiversity and ecosystem services. Specifically, highly simplified agricultural systems (monocultures) that rely heavily on synthetic fertilizers and biocides (e.g. herbicides, fungicides and insecticides) often result in externalities such as water pollution and marine dead zones, pest and weed resistance, pesticide toxicity to animals and humans, and other human health impacts (Diaz and Rosenberg, 2008; Foley *et al.*, 2011; Tilman *et al.*, 2002).

1.7 MOVING TOWARDS SOLUTIONS – COUNTERING OR MITIGATING ADVERSE TRENDS

While many current agricultural practices contribute to ecosystem decline, agriculture itself can form part of the solution by emphasizing agroecological methods. Agroecological methods are knowledge and labour-intensive practices that increase productivity via biological, rather than chemical, mechanisms by understanding and manipulating the ecological processes within the agroecosystem. Examples of agroecological techniques include use of cover crops, crop rotation and crop-livestock mixtures. Through the optimization of natural processes, agroecological farming can promote biodiversity and the regeneration of ecosystem services – both those that provide benefits to society (e.g. carbon sequestration, improved water quality, aesthetic landscapes, wildlife conservation) and those that enhance the productivity, resilience and stability of farms (e.g. pollination, pest control, soil fertility, water storage) (Kremen and Miles, 2012; Zhang *et al.*, 2007).

In the last decade, knowledge of agroecology and the value of ecosystem services has progressed rapidly, yielding protocols for sustainable farming best practices that can be utilized in a variety of farming environments and landscapes. However, many governments still need to take steps to integrate these efforts into decision and policy-making. As indicated, this report pays particular attention to the mainstreaming of pollination services (see Box 3).

Box 3

WHAT IS MAINSTREAMING?

Mainstreaming ecosystem services "means ensuring that the positive or negative impacts of policies on ecosystems and their services are considered during both the policy design and the policy implementation phase", as well as ensuring the existence of policies tailored to the promotion of ecosystem services (Maes *et al.*, 2013). The overarching goal of mainstreaming is to incorporate key concepts into planning processes in all relevant sectors and ultimately to influence human behaviour (Cowling *et al.*, 2008).

There are two major challenges to this effort. First, many of these services are effectively invisible, thus, their value is underappreciated or unrecognized by governments and citizens. Pollination, for example, is frequently taken for granted as a "free" service provided by nature that will inevitably continue. Second, while ecosystem services doubtlessly provide tremendous economic value to individuals, communities and nations, efforts to conserve or restore ecosystem service levels may not show an economic return on investment for several years. For example, if a farmer switches away from pesticides to biologically based pest-control mechanisms, they may not see an increase in native pollinators for several years and thus, must continue to supplement the pollination process with rented honey bees. The long-term nature of conservation and restoration can pose challenges to both individuals in terms of behaviour modification, as well as to policy-makers who want to see a regular return on investment to support the continuation of restoration activities. The intent of this report is to provide strategies for mainstreaming pollination services and also to outline specific pollinator policy approaches in the hope that these challenges may be overcome.

1.8 AGRICULTURE AT A CROSSROADS

It is an opportune time to move forward on mainstreaming ecosystem services at both national and international levels. Major transformations are occurring and momentum in the international dialogue around food and agriculture is increasing, with more attention being paid to the importance of safeguarding ecosystem services and protecting biodiversity, including for pollinators. Box 4 identifies key international sustainability efforts into which ecosystem services (especially pollination services) could be incorporated. Policy measures are also needed at the national and regional levels. Lessons can be derived from initial efforts to incorporate pollinator protection and ecosystem services in agricultural and environmental policy efforts.

Box 4

INTERNATIONAL ENTRY POINTS FOR MAINSTREAMING ECOSYSTEM SERVICES

These international plans and agreements, while in no way exhaustive, offer support for mainstreaming ecosystem services such as pollination into national plans and laws related to these efforts.

- **Post-2015 Sustainable Development Agenda/Sustainable Development Goals: With the Millennium Development Goals set to expire in 2015 several processes are underway to identify the objectives and action items for the next international development agenda, with an increased emphasis on sustainability (UN DESA). This agenda offers an excellent entry point for including the importance of ecosystem service conservation. While not yet ratified or operational, there have been promising movements in this direction. The United Nations working group charged with developing the specific goals and metrics has recently released their proposed agenda, which included the following goal: "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" (Goal 15) (UN Open Working Group SDG, 2014).**
- **Convention on Biological Diversity, National Biodiversity Strategies and Action Plans (NBSAPs): These plans are the main instrument for incorporating the goals of the Convention on Biological Diversity at the national level and provide an opportunity to incorporate ecosystem services in a local and contextualized manner. The Convention has developed a strategic plan for the period 2011–2020, with 20 "ambitious but achievable" targets, known as the Aichi Biodiversity Targets. Target 14 is of particular relevance: "By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable". While a majority of countries have submitted plans, very few have included activities focused on pollination services (http://www.cbd.int/nbsap/).**
- **Committee on World Food Security (CFS): Established in 1974, but reformed in 2009 to include a wider group of stakeholders, the Committee on World Food Security serves as a forum to review**

policies related to food security (http://www.fao.org/cfs/cfs-home/cfs-about/it/). The Committee has developed guideline documents in two policy areas, land tenure and responsible agricultural investment, for United Nation member countries to put into practice. The implementation of these guidelines offers opportunities to incorporate ecosystem services.

- *Voluntary Guidelines on Land Tenure*: This voluntary agreement is intended to "provide guidance to improve the governance of tenure of land, fisheries and forests with the overarching goal of achieving food security". These guidelines acknowledge that sustainable development and management of natural resources is largely influenced by land ownership. Efforts to implement these guidelines could take into account governance of ecosystem services, including pollination (CFS, 2012).
- *Responsible Agricultural Investment*: This set of guidelines identifies principles for responsible agricultural investments. It emphasizes the linkage between the viability of agricultural investments and the health of ecosystems, and suggests taking a "holistic approach in terms of human, animal, environmental and overall public health". This document can serve as a resource for incorporating ecosystem services into agricultural investments (CFS, 2014).

SECTION 2
BACKGROUND ON POLLINATORS AND POLLINATION

2.1 WHAT IS POLLINATION?

Pollination is the process of moving pollen from the male anthers to the female stigma within the same flower or in another flower or individual plant. The transfer of pollen can occur inanimately by gravity, wind and water or *via* living animals. Bees are thought to be the most important pollinators in most environments, including agroecosystems, but many other animals also provide pollination services, including birds, bats, flies, butterflies, moths and beetles. The process of pollination occurs prior to fertilization, which produces fruits, vegetables and seeds for food production, as well as the spread of a plant's genetic material, and thus is critical for agriculture (Buchmann and Nabhan, 1996). Box 5 explores the distinction between wild and managed pollinators.

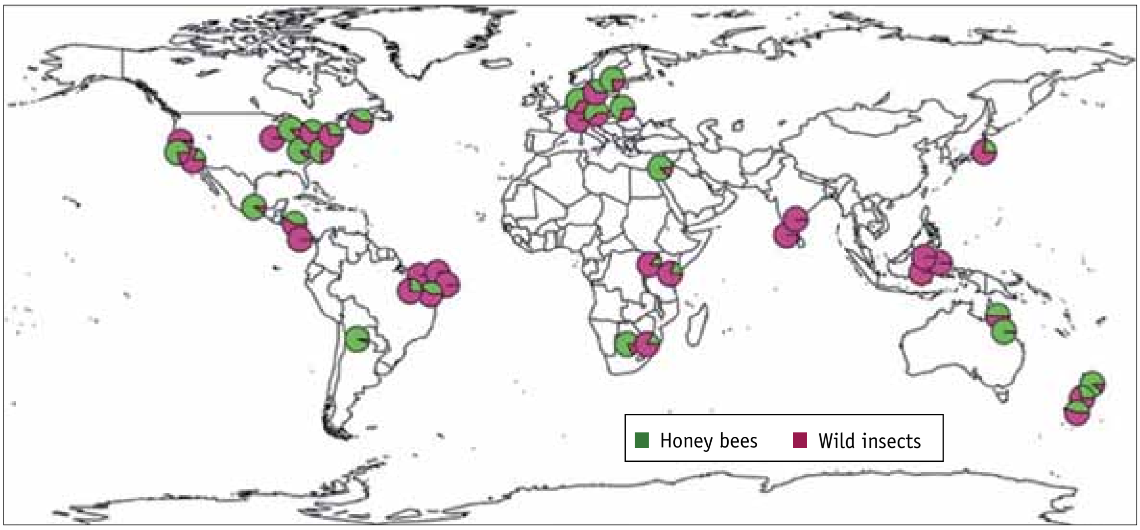
Box 5

WILD VS. MANAGED POLLINATORS

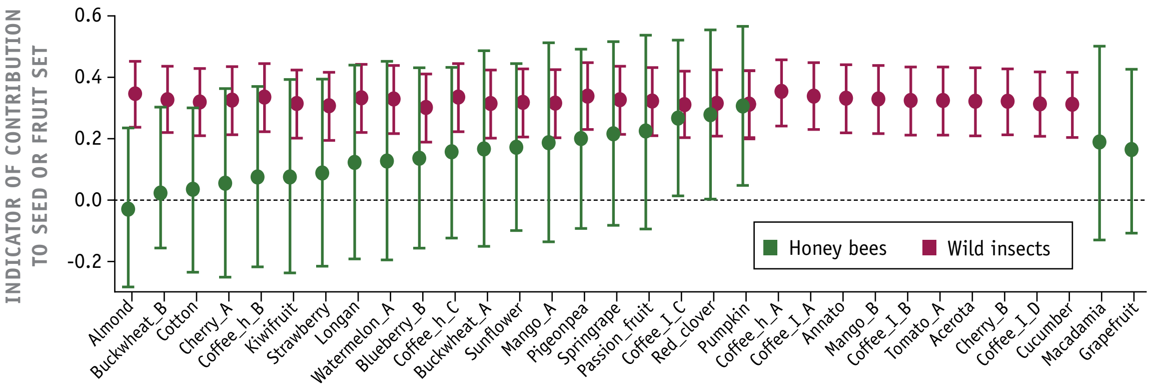
An important distinction must be made between wild and managed pollinators. Both wild and managed pollinators can provide pollination services for agricultural crops. Globally, honey bees (*Apis mellifera*) are the predominant pollinators managed for agricultural use. Honey bees have the capacity to increase yield in the majority of animal pollinated crops (Klein *et al.*, 2007). However, native bees and other wild pollinators also contribute substantially to agricultural production, and their significance worldwide has only been recently appreciated. Specifically, a new global study found that crop yields respond more positively to increases in wild pollinator densities than to increases in honey bee densities. While both honey bees and wild bees contribute to crop pollination, honey bees, it is now known, cannot fully substitute for the positive yield effects attributed to wild pollinators. Although a market has emerged to rent managed pollinators to farmers to pollinate large monoculture crops under intensive production, many farmers around the world rely entirely on wild pollinators (Garibaldi *et al.*, 2013).

Figure 2

CONTRIBUTION OF WILD BEES AND HONEY BEES TO SEED AND FRUIT SET, IN A GLOBAL ANALYSIS



Relative visitation by honey bees and wild insects to flowers of 41 crop systems on six continents. Honey bees occur as domesticated colonies in transportable hives worldwide, as a native species in Europe (rarely) and africa, or as feral population in all other continents except Antarctica.



Source: Garibaldi *et al.*, 2013

2.2 VALUE OF POLLINATION FOR THE GLOBAL FOOD SUPPLY

As indicated previously, pollinators play an important role in sustaining global biodiversity. Eighty-six percent of all flowering plants utilize animal-mediated pollination in order to reproduce (Ollerton *et al.*, 2011). Global trends in production show that the acreage of crops requiring pollination is increasing (Aizen *et al.*, 2008). The overall value of pollination services globally is estimated to be approximately €153 billion per year (Gallai *et al.*, 2009).

Additionally, pollination is a process vital to food security and ensuring the availability of a diverse human diet. Seventy-five percent of the world's major food crops, from cacao to pumpkins, benefit from or are reliant on animal-mediated pollination. While these crops account for only 35 percent of the world's food production by volume (Klein *et al.*, 2007), they provide greater nutritional value in terms of micronutrient content. For example, 98 percent of the available vitamin C, 55 percent of available folate and 70 percent of vitamin A comes from animal-pollinated crop plants. In contrast, most staple crops such as rice and wheat are not reliant on pollinators for reproduction. These crops may represent a larger share of global caloric intake, but contain relatively few vitamins, minerals and other micronutrients important for human health (Eilers *et al.*, 2011).

2.3 DECLINES IN POLLINATION SERVICES AND IMPLICATIONS

Honey bees (*Apis mellifera*), the most common managed pollinator, have experienced exacerbated rates of colony losses across the Global North in recent years, from an average of 30 percent in the United States to as high as 85 percent in the Middle East (Neumann and Carreck, 2010). Less is known about wild pollinator populations due to limited and uncoordinated monitoring systems, but even with imperfect data there are examples of decline and even extinction (Potts *et al.*, 2010). Bumble bees are the most studied group of native bees. Assessment in Europe has shown that 24 percent of bumble bees are faced with extinction and an analysis of the status of all North American bumble bee species, by the Xerces Society in conjunction with the continent's leading bumble bee scientists, shows that approximately one-third of all species face serious threats to their conservation (Hatfield *et al.*, in prep). For example, due to many local population extinctions, the ranges of certain bumble bee (*Bombus*) species in the United States have contracted by up to 87 percent, while relative abundance has declined by 96 percent (Cameron *et al.*, 2011). Furthermore, species losses and dominance by a smaller number of species have been reported in both the Netherlands and the United Kingdom (Biesmeijer *et al.*, 2006). A recent study showed that three-quarters of UK butterflies showed a 10-year decrease in either their distribution or population levels (Fox *et al.*, 2007).

Further losses to pollination services would have serious and substantial economic impacts. Declines in pollination may result in pollination deficits, which typically manifest as reduced crop yields and/or deformed fruit (Klein *et al.*, 2007). Depending on which crops are most affected, these reductions may significantly impact human nutrition in terms of the availability of many micronutrients (Chaplin-Kramer *et al.*, 2014; Eilers *et al.*, 2011). Finally, because of the importance of pollination for conservation of biodiversity, losses of pollinators could affect the abundance and diversity of plant species, which in turn would impact the functionality of the ecosystem and the provision of other ecosystem services (Kevan, 1991).

2.4 MULTIPLE THREATS REQUIRE MULTIPLE APPROACHES

The global declines in pollinator populations and diversity are thought to be the result of several phenomena: habitat destruction, pesticides, diseases and parasites, invasive species and climate change. It is also hypothesized that these individual drivers may combine to produce negative synergistic effects (Potts *et al.*, 2010). In the absence of a single explanation, multiple policy approaches in a variety of sectors must be adopted to mitigate the declines. Chapter 3 identifies some pre-policy considerations and suggested activities to create an enabling policy environment for mainstreaming pollination services. Chapter 4 then outlines some of the thematic areas surrounding successful approaches that take into account the causes of decline.

SECTION 3
POLICY DEVELOPMENT PROCESS

3.1 SUGGESTED PREREQUISITE ACTIVITIES FOR MAINSTREAMING

Research on best management practices and valuation of ecosystem services has increased over the past decade, however the concept of ecosystem services is still not well understood or recognized at the policy level in many regions of the world. While intended to provide a more holistic description of the value and functions of ecosystems, policy-makers often perceive the concept of ecosystem services in largely abstract terms. Thus, concerted and targeted awareness-raising and mainstreaming efforts are essential for both policy-makers and the broader public (Cowling *et al.*, 2008).

One of the challenges to mainstreaming ecosystem services into public policy is that conservation efforts must protect tangible species and resources, as well as less visible ecosystem processes (Global Pollination Project, n.d.). Whereas species protection is often well codified in laws and regulations, policies to support the ecological processes themselves are less common. For example, certain types of species may enjoy legal protection, such as endangered species (e.g. United States Endangered Species Act; International Convention on Trade in Endangered Species) or migratory species (e.g. international treaties on migratory birds), but such species are not always relevant to provision of specific ecosystem services. The objective of this section is to provide considerations for incorporating the concept of ecosystem services into decision-making.

Several actions prior to policy introduction can significantly improve the chances of successful adoption. Table 1 outlines several important considerations identified by Cowling *et al.*, and provides pre-policy activities to facilitate the mainstreaming process (Cowling *et al.*, 2008).

Table 1

KEY CONSIDERATIONS AND PRE-POLICY ACTIVITIES TO FACILITATE MAINSTREAMING

KEY CONSIDERATIONS BEFORE BEGINNING MAINSTREAMING	PRE-POLICY ACTIVITIES TO FACILITATE THE MAINSTREAMING PROCESS
Actors in all relevant sectors, including, those outside of the environmental and natural resource sectors, must understand the importance and value of conserving ecosystem services.	• Conduct outreach and education across government agencies. • Identify messaging strategies that link ecosystem services and environmental conservation to other priority areas such as health, safety, the economy or poverty reduction. Ascertain the elements of importance to a particular policy-maker and tailor the communication strategy accordingly, this increases the likelihood of a receptive audience (Watson, 2005). For example, focusing on the importance of pollination services for fruit and vegetable production may prove a useful "hook" for policy-makers aiming to increase fruit and vegetable intake to improve nutrition and dietary health.
Increased awareness of ecosystem services does not necessarily translate into behavioral changes and/or action.	• Utilize behavioural change strategies such as social marketing, defined as "the theory and practice of marketing an idea, cause, or behavior" (Kotler, 1971, 2011). Common in the health sector, this practice is based on identifying the internal and external barriers to behaviour change and strategizing specific ways to overcome these identified barriers (Cowling *et al.*, 2008). For example, to reduce pesticide use among farmers, this approach would identify common barriers (e.g. lack of knowledge of alternatives) and tailor strategies accordingly (e.g. provide extension materials and services for technical support).
New policy initiatives require human resources, institutional capacity, and funding for successful development and implementation.	• Identify the people and organizations with the interest and expertise to ensure progress on new policy development. Determine the nature of skills, knowledge or resource gaps and establish how they may be bridged (API, 2007). • Plan for and ensure adequate funding and institutional capacity for future policy implementation.
Because ecosystem services operate at many different spatial and temporal scales, the policy response must take into account the corresponding levels of government. Therefore, coordination among agencies is of particular importance. While pollination is managed primarily at the local level, higher-level policies at the regional, national and international levels can also have a major impact.	• Explore the creation of new organizations and/or agencies or develop funding, human resource capacities, training and institutional support within existing agencies to help manage communication, implementation and information across sectors and levels of government. Take advantage of existing capacities where possible for implementation. • Conduct a survey of existing formal laws (statutes, codes, etc.) and informal policies (proclamations, resolutions, etc.) at federal, state and local levels. Catalogue all relevant provisions that may impact the specific ecosystem service and identify potential conflicts between different laws. For example, Brazil (Jorge Da Cunha, 2010) and Canada (Tang *et al.*, 2010) performed surveys to catalogue regulations supportive and harmful to pollinators and identified additional regulations that could effectively include pollinators.

Source: adapted from Cowling *et al.*, 2008.

It is very important to engage with key stakeholders to discuss and identify challenges and possible solutions related to pollinator losses and associated ecosystem service declines. Main stakeholders with strong interests and insights will include farmers (and other land users), representatives from non-government and government organizations, researchers and even food businesses in the supply chain. A consultation process and/or participatory dialogue inclusive of multiple stakeholders is essential to understand and address different perspectives and needs, and will confer many benefits to policy implementation (e.g. higher-quality decisions, greater legitimacy of decisions, increased compliance) (Menzel and Teng, 2009). This kind of discussion can also introduce stakeholders to potential policy ideas, based on information from other regions or countries, and discuss possible implications. Engaging farmers in these processes is particularly important, as they are likely to be impacted directly by potential laws, policies, incentives and so on.

3.2 THE PROCESS OF MAINSTREAMING

Policy is developed through social processes, yet much of ecosystem services research does not acknowledge that this process is often non-linear and subject to political realities and the whims of public discourse. Noting this void, Cowling *et al.* (2008) outlined a pragmatic and user-centred model for mainstreaming ecosystem services, which emphasizes these realities and is based on: (i) socially relevant, user-inspired research; (ii) stakeholder empowerment; and (iii) adaptive management. They identify three phases to successful mainstreaming that are explained below: assessment, planning and management.

Assessment phase

The assessment phase involves a systematic process to collect social, biophysical and economic information about one or more ecosystem service useful for the development of future policy. The *social assessment* identifies the "owners and beneficiaries of ecological functions" and also the possible markets, incentives and barriers to policy implementation. This step focuses on the "needs, values, norms, and behaviours or individuals, institutions, and organizations in the study area. In other words, it provides an understanding of how an area works in socioeconomic terms and why" (Cowling *et al.*, 2008). The *biophysical assessment* identifies the types and locations of the ecosystem services and operationally how various system components work together. Where possible, biophysical assessments can be used in the context of future scenarios to project how ecosystem services will change (Nelson *et al.*, 2009). The *valuation assessment* evaluates economic benefits of the ecosystem service to help managers and policy-makers assess tradeoffs from competing land uses (Cowling *et al.*, 2008).

Planning phase

This phase establishes a strategy with concrete and clear objectives and actions based on the assessments, as well a plan for implementation. It is not uncommon for the data or modelling to drive the process in a way that is disconnected from the needs of local users. It is therefore important that user needs are taken into account in a realistic manner, and that education and outreach programmes about alternatives accompany regulations on pesticides or other policies (Menzel and Teng, 2009). For example, eliminating pesticides entirely might produce the greatest gains to pollinator populations, but may be unreasonable in the short term for local farmers and land users.

Scenario planning can be a useful technique and one that has been used successfully by the Millennium Ecosystem Assessment initiative. "Providing compelling, positive alternatives to the status quo, scenarios can harness stakeholders' energies for strategy development and, thereby, overcome their sense of helplessness about the future" (Cowling *et al.*, 2008).

Management phase

The overarching goal of the management phase is to coordinate activities that safeguard ecosystem services and to ensure that the actions taken benefit the identified beneficiaries (Cowling *et al.*, 2008). In the pollinator context, because the actions necessary to conserve and manage pollinators are not fully understood, management strategies must be adaptive as knowledge is generated (FAO, 2008). Additionally, funding for educational programmes and extension may be needed to provide necessary advice and support to growers who are not accustomed to new regulations, for example, on pesticide use. Similarly, education and outreach may be needed to encourage adoption of alternatives (e.g. on Integrated Pest Management methods), or to enable farmers to understand and utilize incentive policies for conservation practices (e.g. habitat conservation).

SECTION 4 **KEY THEMATIC AREAS AND POLICY OPTIONS**

The following six thematic policy areas provide a primer on some of the major considerations and policies for pollinator conservation and protection. The process of identifying these thematic areas has been through a broad, international consultation, facilitated by the Food and Agriculture Organization of the United Nations (FAO) through its Global Action on Pollination Services for Sustainable Agriculture (www.internationalpollinatorsinitiative.org).

A set of researchers from 11 countries and a network of indigenous people's organizations applied a protocol to assess the extent to which crop systems may be suffering from pollination deficits (Vaissiere, Freitas and Gemmill-Herren, 2011). Preliminary analysis of this large, collaborative dataset indicated that a 100 percent increase in the level of pollination service (which is biologically quite realistic through management practices) results in an increase in yields of 24 percent (Vaissiere, Freitas and Gemmill-Herren, 2011). The meta-analysis of results is ongoing, and will be submitted for publication in early 2015 (Garibaldi, pers. com.)

A workshop convened in Naro Moro, Kenya, in September 2013 of researchers and policy-makers from the 11 countries considered the possible policy responses to these results, as an input to the anticipated IPBES assessment. A conceptual framework developed by the EU STEP (Status and Trends of European Pollinators) project provided a starting point for a general discussion on how the collaboration could organize and articulate policy responses. The list of policy responses developed has formed the basis for the key thematic areas addressed here.

THEMATIC AREA 1

POLLINATOR-FRIENDLY PESTICIDES POLICIES

Pesticides (insecticides, herbicides, fungicides) may have negative impacts on pollinators either directly or indirectly. Direct effects of insecticides can include both lethal and sub-lethal effects. Sub-lethal effects negatively impact individuals or colonies of pollinators without inducing outright mortality, such as behavioural changes that impair the ability to navigate or forage for floral resources. Herbicides indirectly impact pollinators through the elimination of plants used for foraging and nesting materials (Potts *et al.*, 2010). Fungicides may also produce indirect and/or sub-lethal effects on honey bees (Biddinger *et al.*, 2013; Petis *et al.*, 2013;).

One class of insecticides, neonicotinoids, is increasingly implicated in pollinator declines and mass bee kills. This systemic type of insecticide is often applied via seed coatings or soil drenches. Because these compounds are long lasting, water-soluble and are expressed throughout the tissues of the plants to which they are applied, pollinators may be exposed to these pesticides through the pollens and nectar they collect (Goulson, 2013; Hopwood *et al.*, 2012).

Policies to mitigate pesticide risks to pollinators may take hard (regulatory) or soft approaches (voluntary; or through education and training).

Pollinator risk assessment

A first step in addressing pollination concerns with respect to pesticides is to have in place an adequate pollinator risk assessment procedure, as an integral part of pesticide registration within a country. Traditionally, pesticide impacts on honey bees are a fairly standard part of risk assessment, but have not been consistently applied. Many questions remain around the extent to which honey bees are representative of all pollinators, and should be used as a sufficient indicator (FAO, 2013; Fisher and Moriarty, 2011). This constitutes a policy choice requiring governments and the private sector to commit resources: the pesticide industry will need to conduct more comprehensive studies including impacts on wild pollinators, and governments for their part will need to assign staff and resources to undertake risk assessment.

CASE STUDY Assessing the risk of pesticides to wild bees – Brazil, Kenya and the Netherlands

Recognizing the importance of wild bees and that most pesticide regulation schemes do not consider their exposure to pesticides, FAO and partners developed a tool to better understand the pesticide exposure of key crop pollinators (honey bees and wild bees) through the development of risk profiles for cropping systems in three countries: Brazil, Kenya and the

Netherlands. A risk-profiling approach is useful when a comprehensive risk assessment is not available. These profiles first identify focal crops and the specific species that provide pollination and then identify a list of main factors thought to influence pesticide risk (e.g. periods in the growing season when pesticides are applied to the crop). In each of the three countries, these profiles were developed in consultation with crop and pollination experts, through published and unpublished literature, and available pesticide use data. While a profile is generally unable to explicitly quantify risk like a traditional risk assessment and generally offers only a qualitative estimate of exposure, it helps to identify data and knowledge gaps and can be valuable for use in discussion with researchers, regulators, farmers and other land managers (FAO, 2013).

Regulatory options

An important further step is to strengthen the regulatory options for the reduction of pesticide risks to pollinators. This entails, in part, imposing and enforcing restrictions on usage for those pesticides that pose serious risks to pollinators. At present, new pesticides are often tested for toxicity on honey bees only. A more thorough risk assessment is needed that also includes impacts on native pollinators, as noted above.

Regulatory options also entail labelling to advise applicators of risks and mitigation measures, mandatory information exchange between beekeepers and farmers or pesticide applicators, and the possibility for registration refusal or temporary moratoriums (see case study below).

Labels should contain information about toxicity to bees and other pollinators, and risk mitigation suggestions (e.g. details of when to avoid application should be avoided, such as when pollinators are visibly present). Warnings and mitigation strategies should be written in clear language easily understandable by a variety of audiences, and should assume no technical knowledge.

CASE STUDY Bans on pesticides

The following government entities have intentionally banned or restricted neonicotinoids through either through legislative or legal action.

- **European Union**: In December of 2013, the European Commission, the executive body of the European Union, enacted a proposal calling for restrictions on three neonicotinoid pesticides (clothianidin, imidacloprid and thiametoxam). For at least two years, applications of the restricted pesticides are prohibited on plants attractive to bees and usage is restricted to professionals (EU, 2013).

- **City of Eugene, Oregon, United States**: The City of Eugene in the State of Oregon is the first city in the United States to ban the use of neonicotinoid pesticides on municipal lands. Additionally, the city has required all departments to adopt an alternative management plan (i.e. integrated pest management plans) (Eugene Parks and Open Space, 2014).
- **Prince Edward County, Ontario, Canada:** Prince Edward County in Ontario, Canada is the first Canadian municipality to temporarily ban neonicotinoids on municipal lands and has called for the Canadian federal government to follow suit (Prince Edward, 2014).
- **State of Yucatán, Mexico:** In August of 2014, a judge overturned a permit issued to a private company that allowed for the planting of genetically modified soybean seeds coated with neonicotinoids, based on scientific evidence illustrating that the soy seeds posed a threat to bees and honey production (Lakhani, 2014).

Another alternative is to restrict the usage of certain pesticides. The vast majority of pesticides are designated for general use. As such, employees at farms, nurseries and other businesses can often apply these pesticides at their place of employment without obtaining a pesticide applicators license. Highly toxic products should be designated for restricted use, which requires applicators to undergo training, take a test, and obtain a permit to legally apply certain pesticides.

Policy in support of alternative approaches

For restrictions or bans to be successful, however, restrictions should be combined with policy measures that support alternatives to toxic pesticides. Government policies that explicitly allocate resources to the research needed to identify viable alternatives and that promote Integrated Pest Management and Integrated Vector Management are critical to the success of these measures. Integrated Pest Management (IPM) is “an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides” (FAO). IPM strategies rely first on promoting natural enemies of crop pests through habitat manipulation, and only utilize pesticides as a last resort once a threshold of pest pressure has been reached.

If such policy support is in place to promote these approaches, this will lead to education and training programmes offering instruction on practices that require no or reduced pesticide use. Education and training around appropriate pesticide application practices can also play a significant role in ensuring safety for both humans and pollinators alike. Relatively low-cost trainings can be an important entry point for other sustainable land management practices and can target a variety of audiences (e.g. farmer field schools, garden clubs and community groups).

CASE STUDY Pollination in apple orchards in the Hindu-Kush Himalayan Region - Nepal

Apples are an important crop in the Hindu-Kush Himalayan region and are highly pollinator-dependent. In recent years, producers have faced a variety of negative effects on production from bad weather to pollination deficits. In response, the Government of Nepal requested assistance from FAO to address pollination management for improved apple production. In April 2014, a training workshop was held, focusing on identifying the key apple pollinators, their contributions to yield, their nesting and foraging preferences, and farming methods for encouraging or conserving them near apple fields, including integrated pest management to reduce pesticide use. In addition to the technical training, discussion was also held on balancing pest management practices and pollination conservation, and promoting these practices among farmers in the region (Sheffield *et al.*, 2014).

Figure 3.

NEPAL WORKSHOP ON POLLINATION IN APPLE ORCHARDS, APRIL 2014.

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Box 6

POLLINATOR-FRIENDLY PESTICIDE POLICIES – ACTIONABLE ITEMS

- **Conduct thorough risk assessments on new pesticides for impacts on both managed and native pollinators.**
- **Restrict or ban highly toxic persistent systemic insecticides. Where this is unfeasible at the national level, subregional and local governments may be able to implement bans more locally, increasing pressure for national action.**
- **Incorporate pollinator impact into pesticide permitting or licensing processes.**
- **Require pesticide labels to include clear warning language about impacts on pollinators. Support integrated pest management through research and extension programmes.**
- **Enact agricultural policies that promote agricultural methods which reduce pesticide use and adopt IPM strategies as alternatives, such as incentive programmes.**
- **Invest in research to determine the impacts of pesticides on pollinators.**
- **Ensure farmers, land managers and beekeepers have access to training in appropriate pesticide application, including alternatives such as integrated pest management.**
- **Assess and mitigate risks to pollinators on a crop-pollinator-specific basis.**

THEMATIC AREA 2

CONSERVATION AND ENHANCEMENT OF POLLINATOR HABITATS

Both the intensification and extensification of agriculture over the last few decades have resulted in the loss or degradation of pollinator habitats and food sources within agricultural landscapes. The conservation of existing habitats and the rehabilitation of new habitats are therefore crucial to preserving pollinators and providing pollination services to crops.

Conservation and enhancement of habitat can occur through several policy mechanisms at a variety of scales. Generally speaking, the policy tools available are monetary or non-monetary incentives for habitat enhancement, penalties for activities harmful to pollinator habitats such as use of certain pesticides, or mandatory conservation set-asides. Ideally, all of these tools should be accompanied by outreach and education/training to ensure the highest rate of adoption and compliance. Accordingly, agricultural extension services and other outreach actors should utilize information about pollinators for a variety of audiences (e.g. farmers, public land managers, gardeners). Where known pollinator population declines have occurred, invoking endangered species laws or International Union for Conservation of Nature (IUCN) Assessments may provide a vehicle to promote habitat conservation important for individual species.

Each of these available policy options can operate at large or small spatial scales targeting either large landowners or individual homeowners depending on the desired outcome. Many efforts focus on rural landowners, but this should not be at the exclusion of urban landowners. This point is particularly important given the consideration that many pollinators follow migratory patterns requiring connected "stepping stones" (Buchmann and Nabhan, 1996). Gardeners in cities and metropolitan areas can thus play a special role by selecting pollinator-friendly plants in their gardens to create these pathways.

Whereas many of the above programmes are geared for private landowners, public lands also represent an important opportunity for pollinator conservation enhancement with the advantage that these lands are already under government control. Parks, roadsides, rights-of-way and other public lands are prime places to plant pollinator-friendly plants and provide for nesting sites (see Wojcik, 2013).

CASE STUDY Xerces/NRCS agricultural pollinator programme – United States

This effort was started in 2006 as a pilot project in Yolo County California in partnership with farmers, the University of California-Berkeley, the Xerces Society, Audubon Society and the Center for Land-Based Learning. The Xerces Society has since expanded the programme to all 50 states and various territories. This nationwide collaboration offers practical advice and technical support on habitat restoration and management for pollinators. Since its inception, the programme has worked with farmers and the Natural Resource Conservation Service, a division of the US Department of Agriculture (NRCS), to implement over 165 000 acres of wildflower-rich pollinator habitat. It has trained over 38 000 farmers, gardeners, conservationists, government agency staff, educators and land managers to create, manage and protect pollinator habitats. The programme has also successfully collaborated with dozens of farmers to create pollinator habitat demonstration sites across the United States.

Project partners work with farmers across the United States to develop whole-farm pollination conservation and restoration plans outlining activities such as the planting of hedgerows with native, flowering plants and managing on-farm practices such as tillage and pesticide use.

The current partnership is funded through a cost-share agreement between the Xerces Society and the NRCS. This public-private partnership has leveraged over US$4 million from Xerces members, private foundations and corporate donors to provide above and beyond the required 1:1 match requirement of the federal agency. This funding sustains several joint Xerces-NRCS staff biologist positions, who actively assist farmers seeking to enrol in financial assistance programmes offered by the NRCS. Such financial assistance programmes help to offset the cost of installing habitat features such as hedgerows and are a critical link in incentivizing the adoption of conservation efforts by farmers who may not have the financial

Figure 4

POLLINATOR HABITAT CREATED AND SEEDED BY XERCES SOCIETY STAFF AT HEADWATERS FARM IN OREGON, USA

© Brianna Borders

ability to otherwise carry out these efforts. By bringing specialized knowledge on pollinator conservation to the NRCS, the programme has increased the agency's capacity to offer more support to farmers. Consequently, the agency has responded by investing more funds in pollinator-specific projects across the country, in some cases investing millions of dollars more to support farm projects, resulting in the creation of increasing areas of pollinator habitat across the country.

Accompanying scientific studies demonstrate that these hedgerows and other practices are effective at conserving pollinator communities and enhancing pollinator abundance and diversity (Morandin and Kremen, 2013), including rarer and more specialized species (Kremen and M'Gonigle in review; M'Gonigle *et al.*, in revision). Moreover, some studies also show that habitat enhancements can provide increased pollination services to adjacent crops (Blaauw and Isaacs, 2014). Today, this type of ongoing research remains crucial to the success of the work undertaken by Xerces. Consequently, active partnerships with researchers at the University of California, Penn State University, Rutgers University, Michigan State University and the University of Minnesota remain vital to fine-tuning the recommendations provided daily by Xerces to farmers and NRCS staff.

Where government may be unable to provide education or financial incentives for on-farm activities, or support research activities, these sorts of partnerships can help to defray costs and still provide a comprehensive approach to pollinator habitat restoration and conservation and enhancement.

CASE STUDY Urban Pollination Project – United Kingdom

Increasing urbanization in many areas can result in reductions in pollinator habitat, but urban areas can also represent an untapped opportunity for promoting pollinators. The UK Urban Pollination Project, a partnership with the University of Bristol, the University of Reading, the University of Leeds and the University of Edinburgh, looks at how urban areas can help support pollinators. The project also partners with local organizations to plant pollinator-friendly plants in parks, playing fields and school grounds. More than 10 hectares of flower meadows were planted at the site of the London 2012 Olympics to increase foraging resources (Urban Pollinators Project).

Figure 5

AN EXPERIMENTAL PERENNIAL FLOWER MEADOW SOWN AT HORFIELD COMMON IN BRISTOL, UK AS PART OF THE URBAN POLLINATORS PROJECT LED BY THE UNIVERSITY OF BRISTOL, UK

© Katherine Baldock

Box 7

CONSERVATION AND ENHANCEMENT OF POLLINATOR HABITATS – ACTIONABLE ITEMS

- **Promote pollinator habitat conservation through financial or other incentives for beneficial on-farm activities, penalties for harmful activities and/or mandatory habitat set-asides. Accompany these policies and programmes with outreach and education.**
- **Ensure pollinators are included in agricultural advice tailored for a variety of audiences (e.g. farmers, land managers, gardeners) including urban landholders.**
- **Utilize protected species laws and IUCN assessment status to protect pollinators, as appropriate.**
- **Utilize pollinator-friendly plants in public areas (parks, roadsides, public lands, along power lines).**
- **Coordinate with the appropriate local entities (transportation, parks and recreation, agriculture, natural resource management agencies).**

THEMATIC AREA 3

VALUATION, INCENTIVES AND PAYMENTS FOR ECOSYSTEM SERVICES

To solidify the often-invisible or time-delayed linkages between ecosystem services and agriculture, there has been increased interest globally in producing economic valuations of many ecosystem services, so as to convey effectively to policy-makers the importance of the services and benefits they provide (TEEB, 2014). The goal of these valuations is to translate the information into market-based mechanisms or policies to promote conservation.

One approach receiving increasing attention is Payments for Ecosystem Services (PES) schemes. This topic is well covered in the literature and many resources and step-by-step guides for implementing a PES programme already exist. This section therefore provides a simple introduction to the concept (see Smith *et al.*, 2013; Wunder, 2005 for further information). A PES scheme is generally an arrangement whereby "the beneficiaries, or users, of ecosystem services provide payments to the stewards, or providers, of ecosystem services" (Smith *et al.*, 2013). These payments are geared to increase the attractiveness of certain conservation activities when an alternative land use may be more economically beneficial to the land manager (Engel, Pagiola and Wunder, 2008). The duration of these contracts vary, but as with other conservation efforts, longer terms are generally more ideal for achieving the target ecosystem service levels.

PES programmes may be funded through public funds, private funds or a combination of both. The payments must be of a sufficient size to motivate behaviour and/or, at a minimum, allow farmers and landowners to recoup the cost of their time, materials and potential forgone income that would have resulted from alternative land uses. Additionally, to ensure measurable gains in pollination services, the PES programmes must operate at a spatial and temporal scale that is likely to achieve the desired level of pollination. In other words, if only a few landholders engage in a PES programme, the efforts may result in internal (private) benefits, but may not be sufficient to obtain broader pollinator population gains constituting a public benefit. Since payments can represent a substantial cost, a critique of the PES model is that a dedicated and consistent funding stream must be available. Another concern is the limited nature of outreach efforts and consequent lack of engagement with small or poor landholders. Setting specific farm size limits and performing targeted outreach efforts at poor producers may help to address this issue (Wunder, 2005).

Where PES schemes are not feasible, one strategy is to convey the non-monetized benefits gained through preservation of ecosystem services to land managers through outreach and education. In some cases, activities can yield increases in economic returns to crop harvest, and this can act as sufficient incentive for farmers and land managers (see the Uzbekistan case study below). For example, conserving pollinator habitat around cropland may also provide protection for wildlife, preserve populations of beneficial insects that control pests, and improve soil and water quality, among other benefits (Wratten *et al.*, 2012). Additionally, where payment schemes for ecosystem services do not exist, it may be possible to "bundle" services with those for which there is the possibility of payment, such as combining pollination and pest control services with water quality, for which markets often exist (Wunder and Wertz-Kanounnikoff, 2009).

At present, there are apparently no PES schemes in existence that focus primarily on securing, monitoring and paying for a desired level of pollination services. The following case studies, therefore, do not follow strictly the traditional PES model. Instead, these schemes provide some up-front costs for pollination conservation efforts, rather than an ongoing annual payment, to secure a desired level of pollination services. That said, many PES programmes that promote broader sustainable agriculture efforts and provide annual performance payments, may also produce beneficial effects for pollinators. Direct actions that benefit pollinators include the planting of pollinator-friendly plants, conserving natural elements and landscape features, and maintaining set-aside strips with native plants, among others. Some indirect actions include reducing pesticide use and supporting organic practices, crop rotation, diversified farming systems and integrated pest management (Kennedy *et al.*, 2013; Vakrou, 2010).

CASE STUDY Farming with Alternative Pollinators (FAP) – Uzbekistan

The International Center for Agricultural Research in the Dry Areas (ICARDA) is conducting a project in Uzbekistan to introduce the practice of Farming with Alternative Pollinators. Focusing on cucumber (Regional Program, 2013), the project works with smallholders to enhance wild pollinator habitat using low-cost materials, and then assesses the resulting economic gains and impacts on pollinator biodiversity. "FAP includes detailed manuals with calculated income for different agro-ecosystems and different main crops. The increased farmers' income is part of the technology package, as an incentive for farmers to become local champions for ecosystem resilience." Preliminary results show indicators of improved ecosystem services (higher pollinator species diversity) and additional net income gain for farmers, compared to the control sites that did not use FAP practices. Initial assessments indicate that the test sites produced higher numbers of cucumbers and received a higher price per kg due to significantly better cucumber quality (Christmann and Aw-Hassan, 2012).

CASE STUDY Integrated Crop Pollination Project – United States

The Integrated Crop Pollination (ICP) project is a collaborative effort between several research institutions, non-profit organizations and farmers that aims to integrate "habitat enhancement for wild bees, farm management practices to support bees, and use of diverse managed bee species into farm systems" (ICP, 2014). For example, the project found that wildflower plantings next to blueberry fields increased the presence of wild bees, which had a positive impact on crop yields (Isaacs, pers. comm., 2014). As with the Farming with Alternative Pollinators programme, the up-front costs of habitat enhancement were funded – in this case by the US Department of Agriculture Specialty Crops Research Initiative (ICP "Objectives"). By the fourth year of the study, the increase in yields was sufficient to pay the costs of the wildflower habitat enhancements and produce a profit (Blaauw and Isaacs, 2014).

Figure 6

INTEGRATED CROP POLLINATION PROJECT; *BOMBUS IMPATIENS* ON BLUEBERRY

Box 8

VALUATION, INCENTIVES AND PAYMENTS FOR ECOSYSTEM SERVICES – ACTIONABLE ITEMS

- **Incentivize conservation and sustainable agricultural practices through payments for ecosystem services, or initial investments or cost-share arrangements to cover up-front costs.**
- **If PES schemes already exist, consider modifying requested practices to make them beneficial to pollinators.**
- **If payments are not possible, consider bundling pollinator-friendly practices with those for which there is the possibility of payment.**
- **Provide outreach and education to farmers and landowners, emphasizing benefits other beneficial effects to pollinator promotion activities.**

THEMATIC AREA 4

PARTICIPATION, KNOWLEDGE-SHARING AND EMPOWERMENT OF RURAL AND INDIGENOUS PEOPLES AND LOCAL COMMUNITIES

Rural and indigenous people often possess important knowledge related to pollinators and agricultural and land management practices that promote biodiversity. Local stewards of the land and beekeepers are often aware of important trends in biodiversity and pollinator health, even if they may be unaware of the underlying science. And yet, many places lack mechanisms by which this knowledge and expertise can be documented and shared with scientists and policy-makers. In addition, as much of pollination management occurs at the local level, it is important to ensure local voices are included in discussions of national or regional policy that influence pollinators. Existing government networks and working groups related to agriculture, environment and ecosystem management must therefore include representation from local, rural and indigenous people.

It may also be helpful to develop a working group comprising government, science and community members that is inclusive of rural and indigenous communities, and explicitly created to translate evolving science into explicit policy recommendations. A stakeholder analysis process can help to identify the groups to be included. These working groups allow for two-way information sharing and can become an important channel for involving stakeholders in research and action *via* a participatory process. Various forms of technology, including the internet and mobile phone applications, can also help to empower local groups to collect data or connect individuals.

In many regions, apiculture or beekeeping, is an industry on the decline. As global efforts intensify to empower and include women and indigenous farmers, any efforts to promote beekeeping should reach out to these groups.

CASE STUDY Indigenous Pollinators Network

The Indigenous Pollinators Network is a project of the Indigenous Partnership for Agrobiodiversity and Food Sovereignty that seeks to provide a platform for scientists and indigenous people to share their ideas and best practices around pollination. The Network has organized workshops attended by experts, local practitioners and indigenous knowledge holders, where participants shared information on local practices and learned about the status of pollinators more broadly. In 2013, the Network undertook a review of the complex knowledge systems on pollination of local indigenous communities. In the Nilgiri Biosphere Reserve in southern India, the community decided that they would want to contribute equally on the scientific side as on the traditional knowledge side, and asked to be trained in the application of scientific protocols to detect pollination deficits. Coffee (*Coffea arabica*) was identified as an important crop for local indigenous communities of Kotagiri, in the Nilgiris District of Tamil Nadu. Round-table discussions were held with the community, the research team and external members from, for example the Slow Food community. During these discussions, the interests and concerns of the local indigenous communities concerning coffee pollinators and production, in addition to the protection of traditional knowledge, were affirmed. Future plans for the network include local awareness-raising activities, mapping indigenous communities knowledge management and policy advocacy (Gakii, 2013).

Figure 7

LAKHSMI, IRULA TRIBAL GIRL, DAUGHTER OF SIVARAJ OF SAMAIGUDAR VILLAGE

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CASE STUDY Women's beekeeping groups – Kenya

In 2009, the Kenyan Ministry of Agriculture, Livestock and Fisheries in partnership with World Neighbors, a development organization, began working with farmers to introduce beekeeping as a way to diversify livelihoods. Women were provided with new beehives and received training and technical support from Ministry of Agriculture extension workers (Atakos and Recha, 2013). Women's groups formed to support and empower each other and the number of groups increased from five to 15 over four years. Average honey yields doubled from about 5 kg per beehive/year to 10 kg and above (Macoloo *et al.*, 2013). Some groups split earnings among the group or reinvest them into group functions. In addition to the economic benefits from honey production, neighbouring farmers have also experienced improved yields with their mango trees (Atakos and Recha, 2013). This case study offers an example of a government programme that not only promotes pollination services, but also reduces poverty and empowers rural women.

CASE STUDY The Great Sunflower Project – United States

While not specifically a policy approach, the Great Sunflower Project offers a novel example of the use of a web-based platform to empower ordinary citizens to collect data about plants and pollinator interactions and pollinator abundance. The project began in 2008 with volunteers asked to plant sunflowers in their backyard and collect data about pollinator visits. The project has since expanded and opened its data collection to pollinators on all plants in all settings. It now constitutes the largest body of bee data in North America. Web-based technology is versatile and this form of data collection method could be relatively easily created or sponsored by government agencies or public higher education institutions to aid where data gaps exist (Great Sunflower Project).

Figure 8

LEMON QUEEN SUNFLOWER GROWN AT PERALTA ELEMENTARY SCHOOL IN OAKLAND, CALIFORNIA FOR THEIR GREAT SUNFLOWER PROJECT BEE COUNTS

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Box 9

PARTICIPATION, KNOWLEDGE AND EMPOWERMENT OF RURAL AND INDIGENOUS PEOPLE AND LOCAL COMMUNITIES – ACTIONABLE ITEMS

- **Ensure that existing networks and working groups related to agriculture, environment and ecosystem management include representation from local, rural and indigenous people.**
- **Conduct a stakeholder analysis to help identify individuals and groups with a stake in pollination management, making sure to include rural and indigenous groups, women and urban citizens.**
- **Set up a stakeholder-science information-sharing venue.**
- **Utilize technology to empower local citizens to contribute to pollination management.**
- **Consider apiculture promotion in agricultural sector policies.**

THEMATIC AREA 5

SUPPORTING COLLABORATIVE RESEARCH AND OUTREACH

While the level of research and data about pollinators has increased, further investment is needed to fill knowledge gaps. As ecosystem services involve many natural processes and are embedded in socio-ecological systems, collaborative research, especially partnerships between farmers and scientists, is needed to understand ecosystems, their response to alternative forms of management, the precise mechanisms by which they contribute to human well-being, and how these benefits can be incentivized given socio-economic and political realities. Farmers and land managers are unlikely to manage for pollination alone. Its linkages, synergies and trade-offs with other ecosystem services need to be documented.

Regional knowledge about local pollinators varies, however research into the following broad thematic areas would help support pollination efforts:

- pollinator status and trends;
- plant-pollinator interaction, so as to understand specific habitat requirements for individual pollinators;
- how specific agroecosystem management practices influence tradeoffs and synergies among pollination services and other ecosystem services, and the economic costs and benefits of these approaches;
- biologically based organic approaches and other pest control options not harmful to beneficial insects;
- perceptions and attitudes regarding different agroecosystem management practices;
- regulatory and market opportunities and constraints for promoting ecosystem services within agroecosystems;

- continued analysis of the synergistic causes of pollinator decline and the strategies most effective in preventing or slowing the causes; and
- assessments of existing policies in terms of their effectiveness.

Coordination of information is also important. Available research is often scattered and not accessible to farmers and policy-makers. Science-stakeholder groups can help to centralize and disseminate important findings.

In addition to coordination, a crucial component to supporting research on pollinators is strengthening the human resources necessary to identify pollinators and engage in pollination research and extension on farms. There is a need for increased investment in higher education and training programmes for agronomists, agroecologists, taxonomists, entomologists, ecological economists and other scientists whose expertise is critical for the study of pollination. While "citizen scientists" and other volunteers can perform some functions such as monitoring and data collection, there will always be a need for trained taxonomists and pollination researchers. Building farmer-to-farmer training capacities could also be useful in this context, using the farmer field school approach.

Citizen science

National and international efforts have called for increased monitoring of pollinator abundance over time. Using citizen scientists and volunteers to collect data for use in conservation is one cost-effective approach to augment researcher efforts. Research evaluating the quality of citizen scientist data on pollinators suggests that, with modest training, citizen scientists and volunteers can collect useful data about pollinators (Kremen, Ullman and Thorp, 2011). The previously mentioned Great Sunflower Project constitutes a good example of laypeople collecting data about pollinators in their gardens or on hikes and walks.

Pollination deficit protocols for farmers and land managers

FAO has developed a protocol for use at the farm scale by individual farmers to: "(i) detect and assess pollination deficits in field situations in a standard and statistically testable way; and (ii) draw management conclusions from the proposed experiment for possible action to eliminate or at least reduce these deficits. It can also be used simply to assess pollinator density and diversity on a focal crop for comparison purposes among different sites." This protocol is currently being used in several countries and offers another example of monitoring by non-scientists (Vaissiere, Freitas and Gemmill-Herren, 2011).

CASE STUDY Efforts at training taxonomists and parataxonomists

In many regions of the world, insufficient numbers of new taxonomists are being trained. A number of countries have advanced efforts to strengthen these human resources.

- **Brazil:** the International Pollination Course, a two-week field course held annually on pollination biology, has been conducted in Brazil, Costa Rica, Mexico and the United States. Students and researchers in a variety of disciplines come together to learn about pollinator conservation (Projeto Polinizadores do Brasil).
- **Kenya:** the National Museums of Kenya have created a Pollination Ecology and Bee Taxonomy Centre, through which they offer parataxonomy courses (National Museums of Kenya, 2014). A parataxonomist is a layperson trained by a qualified taxonomist in sorting and identification of specimens (generally to a higher taxonomic level such as family or genus) within a certain taxonomic group.

Figure 9.

PARATAXONOMY TRAINING IN KENYA, SEPTEMBER 2013.

© Sara Manetto

Box 10

SUPPORT COLLABORATIVE RESEARCH AND OUTREACH – ACTIONABLE ITEMS

- **Identify gaps in knowledge surrounding pollination services and invest in research, research coordination and the creation of regional clearinghouses.**
- **Strengthen human resources around pollination management through the training of new scientists, citizen scientists and parataxonomists.**
- **Establish citizen science monitoring programmes, where appropriate.**
- **Encourage farmers to utilize pollination deficit protocols such as that developed by FAO.**

THEMATIC AREA 6

PUBLIC AWARENESS RAISING AND KNOWLEDGE SHARING

As with many public policy initiatives, public outreach and raising awareness are key components in building momentum for change. In recent years, films, articles in newspapers and magazines, and workshops have placed pollinators in the public spotlight and interest is growing. It is imperative that advocates and researchers harness this interest and continue to increase citizen knowledge about these charismatic creatures, extending beyond honey bees to include wild pollinators.

Stakeholder coalitions and other environmental, food and agricultural networks can be useful vehicles for coordination and promotion of both media activities and lobbying efforts. Setting up a government-science-community working group with the goal of translating evolving science into explicit policy recommendations on a regular and frequent basis could be utilized for these activities. Additionally, efforts should be made to identify and include other possible allies beyond the expected conservation groups, such as public health and nutrition groups.

When presenting information about pollination services, advocates should consider linking them to causes other people and groups care about (e.g. poverty reduction or human health). Additionally, it is worthwhile exploring creative ways to present pollinator issues through traditional and new media (e.g. blogs, Facebook, Twitter). The Whole Foods marketing campaign described below uses photographs in a creative way to showcase the importance of pollination services.

CASE STUDY Ghana Pollination Project

The Ghana Pollination Project, a network of pollinator researchers and advocates, has held seminars with policy-makers and journalists to raise awareness on biodiversity, pollinator conservation and pollinator importance to the Ghanaian economy and food security. These seminars, as well as other research and promotional activities, have been broadcast through various news outlets and have helped to raise awareness in the broader public about the importance of pollinators (Ghana News Agency, 2014; Government of Ghana, 2012).

CASE STUDY North American Pollinator Protection Campaign (NAPPC)

The North American Pollinator Protection Campaign is a collaboration of more than 120 partner organizations whose goal is to raise awareness, promote conservation and collect scientific research on pollinator protection (NAAPC "About Us"). Other notable activities include: hosting an annual conference, promoting a National Academy of Science panel focused on pollination, providing lobbying efforts for national agriculture legislation such as the US Farm Bill, working with government agencies to establish a National Pollinator Week and developing a pollinator stamp. NAPPC uses creative outreach strategies, such as events for policy-makers in which all food items are labelled to indicate dependence on pollinators (coffee, chocolate, fruits, etc.) (NAAPC "Accomplishments").

CASE STUDY The Xerces Society and the Whole Foods "Share the Buzz" campaign

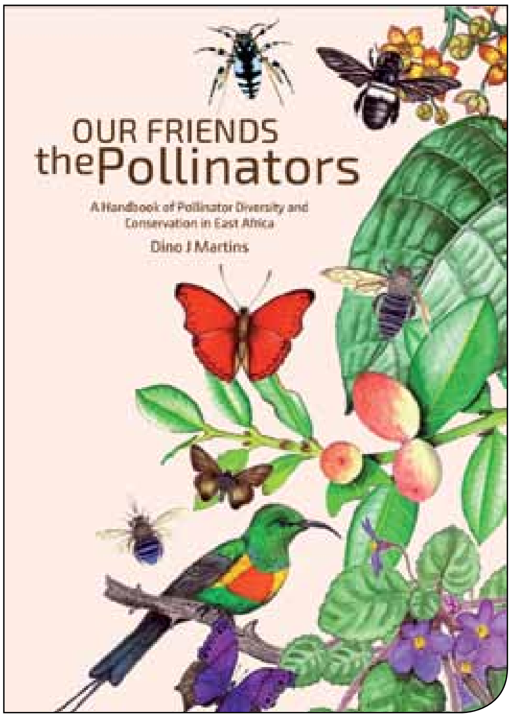
To raise public awareness about pollinators, the Whole Foods Market chain, a high-end grocery chain in the United States, implemented the "Share the Buzz" campaign at hundreds of stores across the country. These stores provided educational messages to hundreds of thousands of consumers. One store also temporarily removed all produce that comes from plants requiring pollinators (237 of 453 products or 52 percent of the produce department). The company partnered with the Xerces Society conservation non-profit for this effort, making a donation to the organization and also presenting customers with ways they as individuals can help conserve pollinators. The campaign used images effectively to show the impact of pollinators on a typical produce department, and thus to strongly emphasize the human diet dependence on pollinators. The story received wide coverage across the United States (Whole Foods Market, 2013). Another media event organized with the Whole Foods company focused on the importance of pollinators for dairy items (Whole Foods Market, 2014).

CASE STUDY Dudu Diaries blog and Our Friends the Pollinators book by Dino Martins – Kenya

Dudu Diaries is an "insect diary" blog (accessible via http://dududiaries.wildlifedirect.org/) authored by entomologist Dr. Dino Martins containing colourful pictures and descriptions of insects primarily from Kenya. Many posts focus on pollination and pollinators. Readers pose questions and send pictures of insects they wish to identify. Additionally, Martins has recently published a book, *Our Friends the Pollinators: A Handbook of Pollinator Diversity and* Conservation, which is available for free download from his blog. Focused on East Africa, the book offers colourful, close-up photographs and descriptions of both pollinators and the plants they pollinate. It is written for non-science audiences to "inspire excitement about pollinators, and make the link with food and people's livelihoods" and "help to shape a strong grassroots movement that works for the protection of habitats, better farming practices, and the restoring of pollination services" (Martins, 2014).

Figure 10

RAISING PUBLIC AWARENESS THROUGH READER-FRIENDLY MATERIAL



© Dino Martins

Box 11

PUBLIC AWARENESS RAISING AND KNOWLEDGE SHARING – ACTIONABLE ITEMS

- **Set up a working group within the country comprising members from the relevant stakeholder groups with the goal of translating evolving science into explicit policy recommendations on a regular and frequent basis.**
- **Conduct a stakeholder analysis to identify other possible allies beyond the expected conservation groups.**
- **Link environmental conservation to other causes people care about, such as poverty reduction or human health.**
- **Explore creative ways to present pollinator issues through new and traditional media.**

OTHER POLICY RESPONSES

In addition to the preceding six thematic areas, the following pollinator policies are also important.

Regulations surrounding movements of managed pollinators

Pests and disease have been cited as contributing to pollinator decline and can spread through the movement of honey bee or bumble bee hives for agricultural purposes. New Zealand has had some success in managing the spread of parasites and disease through prohibiting the movement of hives between the North and South island (Eardley *et al.*, 2006). This regulatory approach may be difficult to enforce within a country.

"Bee friendly" consumer product certification

Consumer product certification is one way to raise awareness and allow consumers to choose products from farmers who utilize "bee friendly" agricultural practices. At present, there is no true third party to certify pollinator efforts. In Canada and the United States, Partners for Sustainable Pollination manages a self-certification process that has certified almost 250 farmers in 34 states and six provinces (Partners for Sustainable Pollination). The Xerces Society also uses a similar approach to let gardeners self-certify through their Bring Back the Pollinator Pledge. Thousands of people have taken this pledge to date (http://www.xerces.org/bringbackthepollinators/)

SECTION 5 **EMERGING ISSUES RELEVANT FOR ECOSYSTEM SERVICES –** POLICIES RELATED TO SUSTAINABLE AGRICULTURE

Many policy efforts that aim to increase the sustainability of agricultural practices, while not focused specifically on pollinators, stand to provide indirect benefits. In contrast, other emerging issues in agriculture may induce negative effects towards pollinators. While not meant to be exhaustive, the following section identifies such policies and themes.

5.1 INNOVATIONS IN SUSTAINABLE AGRICULTURE POLICIES THAT POSITIVELY IMPACT POLLINATORS

Policies calling for the regional adoption of organic farming practices

Governments across the world are involved in efforts to increase adoption of organic farming practices, but in many regions conventional farming still dominates. The country of Bhutan offers an exception to this trend and has recently announced the ambitious goal to switch to fully organic food production over the next decade through an incremental step-by-step and product-by-product approach (Confino, 2014). As the first country in the world to make this bold transition to more ecological farming, the process by which it makes the switch will provide an excellent future case study for mainstreaming and will potentially offer valuable lessons learned for other regions wishing to make a similar conversion.

Many organic farming practices confer benefits to pollinators (e.g. reduced use of pesticides, enhanced floral resources) and thus, the promotion of organics is useful as a strategy for pollinator conservation. Scientific studies show that organic farming enhances the diversity and abundance of pollinator species, particularly when it is broadly adopted in the landscape (Gabriel *et al.*, 2010; Holzschuh, Steffan-Dewenter and Tscharntke, 2008). However, some common organic practices can still harm pollinators. For example, some farmers use tillage as a weed control technique. This may be problematic for pollinators whose nests are underground (Mader, 2010). Thus, policies incentivizing organic farming, as well as education and training surrounding its practices, should include specific pollinator management information including how to mitigate harm to pollinators. The Xerces Society has created and published education materials that deal with this issue (see www.xerces.org/pollinator-conservation/organic-farms/).

Policies incentivizing diversification of farm products

The United States Department of Agriculture recently introduced the Whole-Farm Revenue Protection policy, which allows farmers to insure all crops on their farms at once, as opposed to insuring them crop-by-crop. The lack of specific insurance programmes for fruit and vegetables in the past has been a disincentive for growers to diversify beyond commodity crops. This new way of insuring crops offers farmers enhanced flexibility and provides a greater incentive to diversify cropping systems within farming regions (USDA, 2014). There is evidence to suggest that increased floral diversity achieved through diversified farming can improve pollination services (Kennedy *et al.*, 2013). Policies incentivizing greater diversification of crops complement other efforts to conserve or enhance pollinator habitats, such as the planting of hedgerows (Kearns, Inouye and Waser, 1998).

Policies promoting local and organic food

An alternative means of promoting sustainable agriculture policies is through demand-side channels such as food procurement policies. The City of Malmo, Sweden, has adopted a policy requiring all food served or ordered by the city to be climate friendly, organic and ethically certified (where appropriate) by 2020. Schools, health care organizations and public hospitality agencies are expected to adhere to this policy. Since municipalities tend not to have great influence on national agriculture policies, emphasizing sustainability in food purchasing can be an indirect way to support ecological farming practices that benefit pollinators and other ecosystem services (City of Malmo Sweden).

SECTION 6 **CONCLUSION**

Ecosystems support human life and provide important inputs to the global economy through both goods and services. And yet, despite their importance, many ecosystem services across the world are being degraded more rapidly then they can be renewed, and are not adequately recognized and protected within many policy environments. Policy measures are needed to promote the restoration and conservation of healthy, functioning ecosystems that can produce services such as water purification, soil formation and pollination services.

Pollination offers one example of an ecosystem service in decline where effective policy responses exist that fit conditions at a variety of scales – local, regional, national and international. Because there are multiple causes contributing to the decline of pollinators, multiple and complementary efforts are needed – from bans and regulations on pesticide use to incentives for sustainable agriculture practices promoting pollinator communities. By mainstreaming pollination services into public policy, governments can act now to stem future pollination declines that could significantly impact agriculture and the economy, human nutrition and the conservation of biodiversity.

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*Wild bee (*Nomia *sp.) visiting an eggplant flower, Kenya*

Giant Asian honey bee on mustard in Chitwan, Nepal

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This publication addresses the need to strengthen the interface between the scientific community, knowledge-holders and policymakers, and build capacity for and strengthen the use of science and knowledge in policymaking on the topic of ecosystem services. With respect to the ecosystem service of pollination, FAO developed a protocol to identify and assess pollination deficits in crops – resulting in a global meta-analysis, with data from eleven countries. Results emerging from this endeavour give strong indication that pollination deficits may exist in a wide variety of farming systems across the world. As a response to this science, researchers and policymakers from the eleven countries considered the range and types of actions that can address pollination deficits, and developed an indicative set of policy responses. This publication is a result of this work, which considers the mainstreaming of ecosystem services at both national and international levels, with a focus on pollination services.

GLOBAL ACTION ON **POLLINATION SERVICES**
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