CHAPTER **5**

BIOCULTURAL DIVERSITY, POLLINATORS AND THEIR SOCIO-CULTURAL VALUES

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EXECUTIVE SUMMARY

Diverse knowledge systems, including science and indigenous and local knowledge (ILK), contribute to understanding pollinators and pollination, their economic, environmental and socio-cultural values and their management globally *(well established)*. Scientific knowledge provides extensive and multidimensional understanding of pollinators and pollination, resulting in detailed understanding of their diversity, functions and steps needed to protect pollinators and the values they produce. In indigenous and local knowledge systems, pollination processes are often understood, celebrated and managed holistically in terms of maintaining values through fostering fertility, fecundity, spirituality and diversity of farms, gardens, and other habitats. The combined use of economic, socio-cultural and holistic valuation of pollinator gains and losses, using multiple knowledge systems, brings different perspectives from different stakeholder groups, providing more information for the management of and decision-making about pollinators and pollination, although key knowledge gaps remain (5.1.1, 5.1.2, 5.1.3., 5.1.4, 5.1.5, 5.2.1., 5.2.5, 5.3.1, 5.5, **figure 5-2, Boxes 5-1, 5-2**).

Pollinator-dependent food products are important contributors to healthy human diets and nutritional security *(well established)*. Crop plants that depend fully or partially on animal pollinators contain more than 90% of vitamin C, most of lycopene, the antioxidants beta-cryptoxanthin and beta-tocopherol, vitamin A and related carotenoids, calcium and fluoride, and a large portion of folic acid available worldwide. Pollinator insects, including the larvae of beetles, moths, bees, and palm weevils constitute a significant proportion of ~ 2,000 insect species consumed globally, recognised as potentially important for food security, being high in protein, vitamins and minerals (5.2.2).

Pollinators are a source of multiple benefits to people, well beyond food-provisioning alone, contributing directly to medicines, biofuels, fibres, construction materials, musical instruments, arts and crafts and as sources of inspiration for art, music, literature, religion and technology *(well established)*. For example, anti-bacterial, anti-fungal and anti-diabetic agents are derived from honey; *Jatropha* oil, cotton and eucalyptus trees are examples of pollinator-dependent biofuel, fibre and timber sources respectively; beeswax can be used to protect and maintain fine musical instruments. Artistic, literary and religious inspiration from pollinators includes popular and classical music (e.g., I'm a King Bee by Slim Harpo, the flight of the Bumblebee by Rimsky-Korsakov); sacred passages about bees in the Mayan codices (e.g., stingless bees), the *Surat An-Naĥl* in the Qur'an, the three-bee motif of Pope Urban VIII in the Vatican and sacred passages from Hinduism, Buddhism and Chinese traditions such as the Chuang Tzu. Pollinator-inspired technical design is reflected in the visually guided flight of robots, and the 10 metre telescopic nets used by some amateur entomologists today (5.2.1, 5.2.2, 5.2.3, 5.2.4 **case examples 5-2, 5-16**, and **figures 5-7, 5-8, 5-9, 5-10, 5-24**).

Livelihoods based on beekeeping and honey hunting are an anchor for many rural economies and are the source of multiple educational and recreational benefits in both rural and urban contexts *(well established)*. Many rural economies favour beekeeping and honey hunting, as minimal investment is required; diverse products can be sold; diverse forms of ownership support access; family nutrition and medicinal benefits can be derived from it; the timing and location of activities are flexible; and numerous links exist with cultural and social institutions. Beekeeping has been identified as a potentially effective intervention tool for reducing relapses in youth criminal behaviour; a rapidly expanding ecologically-inspired urban lifestyle choice; a source for the growing market demand for local honey; the basis for gaining and transmitting knowledge about ecological processes; and a tool for empowering youth to link biodiversity, culture and society and take action on issues of environmental impacts on pollinators and pollination. Significant unrealized potential exists for beekeeping as a sustainable livelihood activity in developing world contexts (5.2.8.4, 5.3.5, 5.4.6.1, **case examples 5-10, 5-11, 5-12, 5-13, 5-14, 5-21, 5-24, 5-25**, and **figures 5-12, 5-13, 5-14, 5-15, 5-22**).

A number of cultural practices based on indigenous and local knowledge contribute to supporting an abundance and diversity of pollinators and maintaining valued "biocultural diversity" (for the purposes of this assessment, biological and cultural diversity and the links between them are referred to as

"biocultural diversity") *(established but incomplete)*. This includes practices of diverse farming system; of favouring heterogeneity in landscapes and gardens; of kinship relationships that protect many specific pollinators; of using biotemporal indicators that rely on distinguishing a great range of pollinators; and of tending to the conservation of nesting trees, floral and other pollinator resources. The ongoing linkages among these cultural practices, the underpinning indigenous and local knowledge (including multiple local language names for diverse pollinators) and pollinators constitute elements of "biocultural diversity"[1]. Areas where "biocultural diversity" is maintained are valued globally for their roles in protecting both threatened species and endangered languages. While the extent of these areas is clearly considerable, for example extending over 30 per cent of forests in developing countries, key gaps remain in the understanding of their location, status and trends (5.1.3, 5.2.5, 5.2.6, 5.2.7, 5.4.7.2, **case examples 5-1, 5-3, 5-5, 5-6, figures 5-4, 5-11**).

Diversified farming systems, some linked to indigenous and local knowledge, represent an important pollination-friendly addition to industrial agriculture and include swidden, home gardens, commodity agroforestry and bee farming systems *(established but incomplete)*. While small holdings (less than 2 hectares) constitute about 8-16 per cent of global farm land, large gaps exist in our knowledge on the area of diversified farming systems linked to indigenous and local knowledge. Diversified farming systems foster agro-biodiversity and pollination through crop rotation, the promotion of habitat at diverse stages of succession, diversity and abundance of floral resources; ongoing incorporation of wild resources and inclusion of tree canopy species; innovations, for example, in apiaries, swarm capture, and pest control; and adaptation to social-environmental change, for example, the incorporation of new invasive bee species and pollination resources into farming practices (5.2.8, **case examples 5-7, 5-8, 5-9, 5-10, 5-11, 5-12, 5-13, and figures 5-14, 5-15, 5-22**).

A good quality of life for many people relies on ongoing roles of pollinators in globally significant heritage; as symbols of identity; as aesthetically significant landscapes and animals, in social relations, for education and recreation in governance interactions of indigenous peoples and local communities *(well established)*. As examples, the World Heritage site the Agave Landscape and Ancient Industrial Facilities of Tequila depends on bat pollination to maintain agave genetic diversity and health; people show marked aesthetic preferences for the flowering season in diverse European cultural landscapes; a hummingbird is the national symbol of Jamaica, a sunbird of Singapore, and an endemic birdwing the national butterfly of Sri Lanka; seven-foot wide butterfly masks symbolize fertility in festivals of Bwa people of Burkina Faso; and the Tagbanua people of the Philippines, according to their tradition, interact with two bee deities living in the forest and karst as the ultimate authority for their shifting agriculture (5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.3.6, **case examples 5-16, 5-17, 5-18, 5-19 and 5-20, and figures 5-16, 5-17, 5-18, 5-19, 5-20, 5-21**).

Managing and mitigating the impacts of the declines on pollinators' decline on peoples' good quality of life could benefit from responses that address loss of access to traditional territories, changes to traditional knowledge, tenure and governance, and the interacting, cumulative effects of direct drivers *(established but incomplete)*. A number of integrated responses that address these drivers of pollinator declines have been identified: 1) food security, including the ability to determine one's own agricultural and food policies, resilience and ecological intensification; 2); conservation of biological diversity and cultural diversity and the links between them; 3) strengthening traditional governance that supports pollinators; rights-based approaches; 4) prior and informed consent for conservation, development and knowledge-sharing; 5) recognizing tenure); 6) recognizing significant agricultural, biological and cultural heritage, and 7) framing conservation to link with peoples' values (5.4, **case examples 5-18, 5-19, 5-20, 5-21, 5-22, 5-23, 5-24, 5-25, 5-26, figures 5-26, 5-27, box 5-3**).

Indigenous and local knowledge systems, in co-production with science, can be sources of solutions for the present challenges confronting pollinators and pollination *(established but incomplete)*. Knowledge co-production activities among farmers, indigenous peoples, local communities and scientists have led to numerous relevant insights including: improvements in hive design for bee health, understanding pesticide uptake into medicinal plants and the impacts of mistletoe parasite on pollinator resources; identification of species of stingless bee new to science; establishing baselines to understand trends in pollinators; improvements in economic returns from forest honey; identification of change from traditional shade-grown to sun grown coffee as the cause of declines in migratory bird populations; and a policy response to risk of harm to pollinators leading to a restriction on the use of neonicotinoids in the European Union (5.4.1, 5.4.2.2, 5.4.7.3, **tables 5-4 and 5-5**).

Many actions to support pollinators are hampered in their implementation through governance deficits,

1. In the IPBES Conceptual Framework the definition of biocultural diversity is "the total variety exhibited by the world's natural and cultural systems, explicitly considers the idea that culture and nature are mutually constituting, and denotes three concepts: Firstly, diversity of life includes human cultures and languages; secondly, links exist between biodiversity and cultural diversity; and finally, these links have developed over time through mutual adaptation and possibly co-evolution. Biocultural diversity incorporates ethnobiodiversity" (Diaz *et al.*, 2015)

including fragmented multi-level administrative units, mismatches between fine-scale variation in practices that protect pollinators and homogenizing broad-scale government policy, contradictory policy goals across sectors and contests over land use *(established but incomplete)*. Co-ordinated, collaborative action and knowledge sharing that forges linkages across sectors (e.g., agriculture and nature conservation), across jurisdictions (e.g., private, Government, not-for-profit), and among levels (e.g., local, national, global) can overcome many of these governance deficits. The establishment of social norms, habits, and motivation that are the key to effective governance outcomes involves long time frames (5.4.2.8, 5.4.7.4).

Foreword to Chapter 5

Pollination, there are many pollinators, not just bees. For example, the birds that fly from one place to another. Bees fly from one branch to another and carry with them the pollen and maybe we see a change in the colour of the trees. An ant visits a flower, travelling to another one, carrying the pollen from one to the next… Seeing all of this, I have to say that the Guna have a different way of seeing things. We don't see things in their parts, everything is more holistic. When we see a human being, we don't just see two ears, that person has his or her own intelligence. We all need each other—animals, plants and humans. All beings are alive—rocks have their spirit because they help us, perhaps in traditional medicine. Our world is very different, no one dedicates him or herself to just one activity. Belisario López, oral presentation p.41 (López et al. 2015) **(Figure 5-1)**.

We do not see pollination as a separate theme. Rather that everything— trees, rivers, the wind, even human beings—participates in the process. We cannot separate them. Elmer Enrico Gonzalez López, oral presentation p 42 (López et al. 2015).

A group of Guna people, as representatives of the host people, attended the *Global Dialogue Workshop on ILK of pollination and pollinators associated with food production*, Panama City, 1-5 December 2014 (Lyver *et al.*, 2015). These quotations are taken from their oral presentations at the Workshop.

5.1 INTRODUCTION

5.1.1 Diversity of knowledge systems and the IPBES Conceptual Framework

This chapter addresses the topics identified in the scoping study (IPBES 2/17, p. 71) as "non-economic valuation, with special emphasis on the experience of indigenous and local communities, of impacts of the decline of diversity and/or populations of pollinators… Management and mitigation options as appropriate to different visions, approaches and knowledge systems". The IPBES Conceptual Framework, which recognises that the world views of people influence their understandings about nature, and nature's benefits to people and good quality of life, underpins the approach to the chapter (Díaz *et al.*, 2015a). For example, nature's benefits to people can be understood as ecosystem services, such as those provided by bees to pollinate several

FIGURE **5-1**

Mola, embroidered cloth made by Guna people, of bee and butterfly spirits. © The Guna People.

The use of this image is a collective right owned by the Guna People, that has been authorized by the Guna General Congress according to the Resolution No. 1 of 22 November 2002 issued by the Department of Industrial Property Registry of the Ministry of Commerce and Industry.

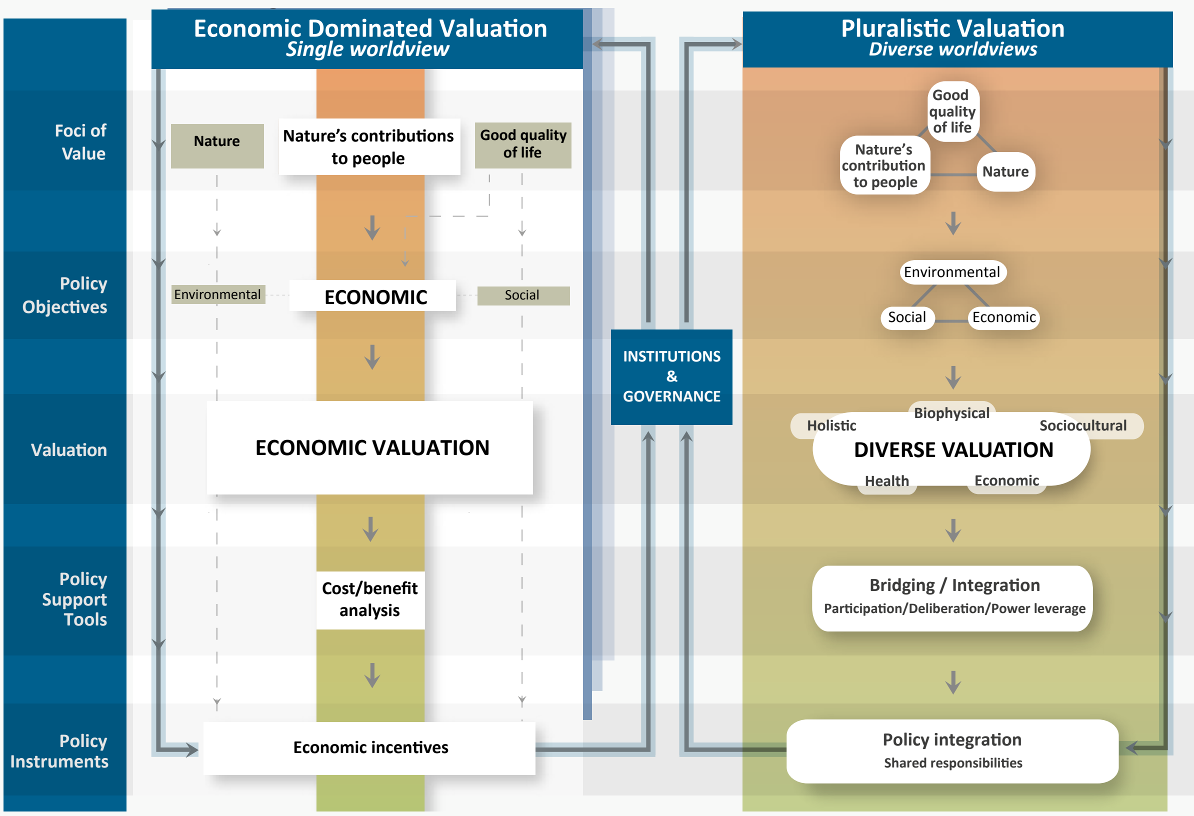
of the world's main crops (Gallai *et al.*, 2009); and as gifts of the gods, as stingless bees and beekeeping are understood among Mayan-descendant people (Sharer, 2006). Multiple knowledge systems of people, including scientific, technical, practitioner and indigenous and local knowledge systems, influence how pollination is understood and valued. Values and knowledge systems are dynamic, changing in response to new information, and to socio-cultural embeddedness and multidimensionality (Brondizio *et al.*, 2010). Assessment of the values of the contribution of pollination and pollinators to nature's benefits to people, and to good quality of life, therefore requires diverse valuation methods (IPBES, 2015). In this chapter, we provide an assessment of these values, focusing on scientific and indigenous and local peoples' knowledge (ILK) systems, and on socio-cultural and holistic valuation approaches **(Figure 5-2)**. Chapter 2 and Chapter 4 provide assessments based on biophysical and economic valuation approaches respectively.

Focusing on different knowledge systems brings greater depth and breadth to our understanding of the value of pollination and pollinators (IPBES, 2015). There are several dimensions that characterise the differences between knowledge systems. These include concepts about what constitutes valid knowledge and how we can obtain it—its epistemology—including domains such as truth criteria, rules of transmission and of validation, attribution of authorship or other rights over knowledge, and many others (Crotty, 1998; Cash *et al.*, 2003; Vadrot, 2014). For example, the notion of individual authorship has become prevalent in Western thought since the late seventeenth century, whereas authorship of songs and poetry is most often attributed to spirits or enemies among Amerindian peoples. Knowledge authority may depend on having been acquired from a chain of authorized knowledge holders, or on first-hand experience, body training or life and dream experience. Knowledge can be esoteric, reserved to some holders such as male children, or exoteric, shared and transmitted openly with anyone in the community (Carneiro da Cunha, 2009, 2012).

A system of knowledge is also distinguished from others according to its ideas about what constitutes reality, about what kinds of things exist — its ontology (Descola, 2014). The world is not just a given, a "reality", that we simply capture through our senses. Rather, clusters of

FIGURE **5-2**

Diverse world-views, knowledge systems, types of values and valuation approaches for assessing nature, nature's benefits to people, and good quality of life. (Based on IPBES, 2015).



environmental qualities are understood through “ontological filters”, that allow us to look for certain qualities and detect them, while we ignore others. For example, the Tuawhenua Māori of New Zealand recognize that people, bats, birds, insects, plants, mountains, rivers and lakes are connected together by genealogical ties *(tatai whakapapa).* When a child is born, these ties are enacted by the burying of the placenta and umbilical cord on tribal lands, thus consolidating ties to Papatuanuku, Mother Earth (Doherty and Tumarae-Teka, 2015). In Bangka-Belitung, Indonesia “where spirits are everywhere, the use of natural resources (terrestrial and aquatic) within a territory is supported by custom *(adat)* and the village authority (the *dukun kampung*) who acts as an intermediary between villagers and the local spirits” (Césard and Heri, 2015).

In contrast, seeing nature as separate from culture became dominant in Western societies after the 17th Century, based on Descartes’ portrayal of human beings as masters of nature (Descartes, 1637 [2005]), and the expectation that Newtonian mechanics could predict nature’s behavior by mathematical rules and monitor it by command-and-control systems, removing ideas about spiritual influences (Newton, 1687; [2014], Davoudi, 2014). More recently, contemporary conservation science itself has been characterised as moving from nature – people dualism towards a framing around “people and nature”, which has benefits as well as risks (Mace, 2014). This shift is partly in response to the narrowness and market-orientation of the ecosystem services framework (Turnhout *et al.*, 2014). Sustainability challenges have shifted science towards embracing pluralism and co-production with other knowledge systems through interdisciplinary and transdisciplinary approaches (Repko, 2012). Indigenous and local knowledge systems also change; for example indigenous communities in Australia have adapted to take account of myrtle rust, a serious fungal disease affecting flowers and spread by insect pollinators, among other agents, developing new partnerships with scientists to co-produce knowledge and management (Robinson *et al.*, 2015).

The IPBES Conceptual Framework provides a basis to be inclusive of, and provide linkages among, this wide array of knowledge systems, with their diverse ontologies and epistemologies (Díaz *et al.*, 2015b). While differences among knowledge systems can create profound misunderstandings, people can find points of connection, agreeing on phenomena while disagreeing on their interpretation (da Costa and French, 2003; Almeida, 2013). Diverse knowledge systems can provide a multiple evidence base, leading to a richer understanding and more effective policy-relevant information (Tengö *et al.*, 2014). The remainder of this introductory section explains and justifies our focus on science and ILK; the linkages with the concept of biocultural diversity; the socio-cultural and holistic valuation approaches, and associated categories adopted. Parts two and three of the chapter present an assessment of the values associated with the contribution of pollination and pollinators to *nature’s benefits to people*, and part three *to good quality of life*. Part four considers the impacts of declines of pollinators and pollination on these values, and vice versa, and potential management and mitigation options. The methods for conducting the assessment are presented in part 5, and part 6 presents the conclusions from this chapter.

5.1.2 Focus on scientific and indigenous and local knowledge systems

The focus on scientific knowledge systems for this pollination assessment is fundamental, as IPBES was established with the overall goal of ‘strengthening the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development’[2]. Scientific contributions to understanding pollinators and pollination are extensive and multidimensional, stimulated by Camerarius’ first empirical demonstration in 1694 that plants reproduce sexually (Ducker and Knox, 1985), and Darwin’s (Darwin, 1862 [2004]) book on the pollination of orchids. Pollinator and pollination science now includes diverse aspects across the ecology of both wild and domesticated pollinator communities and habitats, the genomics of pollinator-dependent species, the molecular biology of pollinator-attractants produced by flowers, the influence of drivers of environmental change, knowledge of substances such as pesticides, and more. Several contemporary journals and research centres are devoted entirely to aspects of the science of pollination, e.g., Journal of Pollination Ecology and the Center for Pollinator Research at Pennsylvania State University.

In addition to this fundamental focus on scientific knowledge, IPBES has adopted as one of eleven guiding principles, a commitment to ‘recognize and respect the contribution of indigenous and local knowledge to the conservation and sustainable use of biodiversity and ecosystems’. Indigenous and local knowledge (ILK) systems are highly diverse and dynamic, existing at the interface between the enormous diversity of ecosystems worldwide and the diversity of livelihood systems (e.g., farmers, fishers, beekeepers, pastoralists, hunter-gatherers, etc.) (Thaman *et al.*, 2013). Our treatment of ILK systems here is guided by definitions that recognize the complexity, diversity and dynamism of human communities, and that self-identification, rather than formal definition, is the key (Martinez-Cobo, 1986; ILO, 1989; Borrini-Feyerabend and Hill, 2015). Indigenous societies share common characteristics such as being linked to territories, having continued occupation of those

2. http:www.ipbes.net.au

territories over long times, and operating under their own customary law systems. Local peoples are characterized by living together in a common territory where they frequent face-to-face interactions, share aspects of livelihoods, and approaches such as collective management of common property or particular farming practices **(Box 5-1)**.

Dynamism is also a key characteristic of indigenous peoples' and local communities' knowledge systems (ILKS), reflecting innovations, as well as a history of interactions with other peoples through trans-continental contacts over millennia, migrations, and the more recent processes of colonization and post-colonial assertion of rights (Coombes *et al.*, 2013; Roullier *et al.*, 2013). Guided by Berkes (2012) and Díaz *et al.*'s 2015 definition we consider ILK systems to be cumulative bodies of knowledge, practice and belief, evolving by adaptive processes and transmitted through cultural and intergenerational processes, about the relationship of living beings (including humans) with one another and with their environment.

BOX **5-1**
Who are indigenous peoples and local communities?

The United Nations recognizes that no formal definition of whom are indigenous peoples and/or local communities is needed — self-identification is the key requirement. This assessment is guided by discussions that recognize the complexity, diversity and dynamism of human communities (Martinez-Cobo, 1986; ILO, 1989; Borrini-Feyerabend and Hill, 2015).

Indigenous peoples include communities, tribal groups and nations, who self-identify as indigenous to the territories they occupy, and whose organisation is based fully or partially on their own customs, traditions, and laws. Indigenous peoples have historical continuity with societies present at the time of conquest or colonisation by peoples with whom they now often share their territories. Indigenous peoples consider themselves distinct from other sectors of the societies now prevailing on all or part of their territories.

Local communities are groups of people living together in a common territory, where they are likely to have face-to-face encounters and/or mutual influences in their daily lives. These interactions usually involve aspects of livelihoods — such as managing natural resources held as 'commons', sharing knowledge, practices and culture. Local communities may be settled together or they may be mobile according to seasons and customary practices. Self-identification is also the key determinant of whether people consider themselves to be local communities.

Communities that come together in urban settings around common interests, such as beekeeping, are considered here to be "communities of interest" rather than local communities.

BOX **5-2**
What are indigenous and local knowledge systems?

The consideration of indigenous and local knowledge in this assessment is guided by Díaz *et al.*'s 2015 definition of ILK to be a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. It is also referred to indigenous, local or traditional knowledge, traditional ecological/environmental knowledge (TEK), farmers' or fishers' knowledge, ethnoscience, indigenous science, folk science, and many other titles.

We also recognize that ILKS are *dynamic* bodies *of social-ecological* knowledge, involving creative as well as adaptive processes, *grounded in territory*, and cultural as well as intergenerational transmission. ILK is often an assemblage of different types of knowledge (written, oral, tacit, practical, and scientific) that is empirically tested, applied and validated by local communities. Hybrid forms of knowledge, negotiated among science, practice, technical, and ILK systems, and variously termed usable knowledge, working knowledge, actionable knowledge, situated knowledge and multiple evidence base are frequently applied pragmatically to the challenges of biodiversity loss (Barber *et al.*, 2014, Tengö *et al.*, 2014, Robinson *et al.*, 2015).

ILKS are found in remote and developing world contexts and also continue within highly industrialised settings. Examples include the "satoyama-satoumi" systems in Japan and Asia (Duraiappah *et al.*, 2012); many transhumance (the seasonal movement of people with their livestock between fixed summer and winter pastures), agricultural, forestry and fisheries systems across industrialised Europe (Hernandez-Morcillo *et al.*, 2014); and reindeer herders in the Arctic (Riseth, 2007).

In many cases, management based on ILK systems has produced sustainably over millennia; in other cases, ILK-based systems have proved mal-adaptive and had a major destructive influence on biodiversity and associated pollinators, sometimes leading to the disintegration of human societies (Diamond, 2005). Ostrom (1990) established that the types of institutional arrangements that support common property systems of governance are critical determinants of whether sustainability results from local management systems. ILK that is relevant to pollinators and pollination therefore importantly includes knowledge of social institutions and governance systems that foster sustainable relationships with pollinators, as well as environmental observations, interpretations, and resource use practices (Berkes and Turner, 2006; Gómez-Baggethun *et al.*, 2013). Language, naming and classification systems, rituals, spirituality and worldviews are integral to ILKS (ICSU, 2002). Validity of ILK arises from the relevant societies exercising their ability to generate, transform, transmit, hybridize, apply and validate knowledge (Tengö *et al.*, 2014); understanding ILK *in-situ* is therefore the priority in working with ILK in biodiversity assessment, rather than a focus on knowledge extracted into literature and other forms (Gómez-Baggethun and Reyes-García, 2013) **(Box 5-2)**.

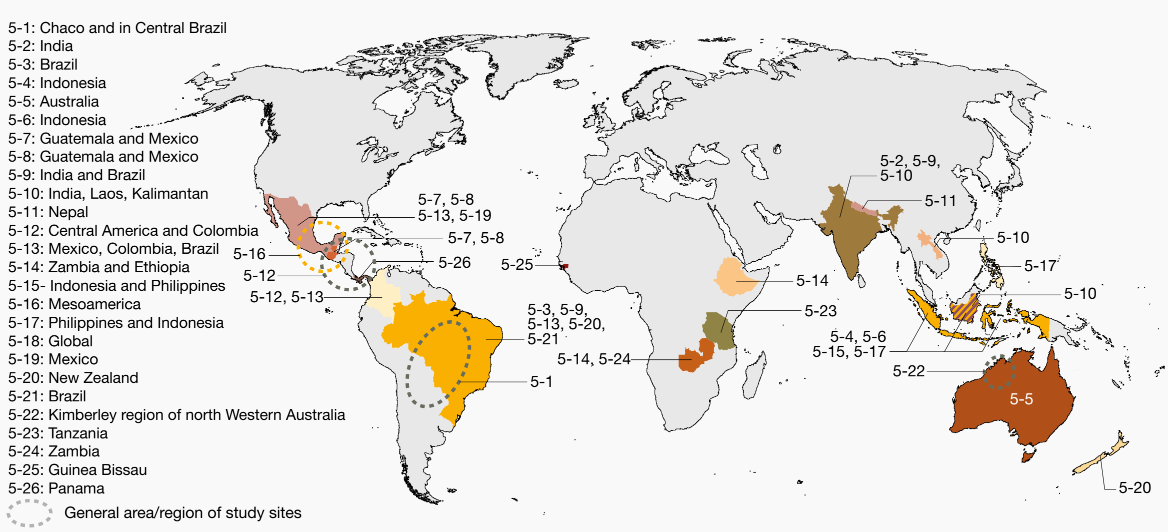
Pollination processes in ILK systems are often understood, celebrated and managed holistically in terms of maintaining values through fostering fertility, fecundity, spirituality and diversity of farms, gardens, and other habitats (Lyver *et al.*, 2015). In this chapter we present case examples from around the world to illustrate aspects of these holistic understandings and their influence on pollinators and pollination **(Figure 5-3)**. We highlight "Co-produced case examples" where direct interaction with ILK-holders has occurred with their *in-situ* knowledge systems.

5.1.3 Indigenous and local knowledge systems and biocultural diversity

For the purposes of this assessment, biological and cultural diversity and the links between them are referred to as "biocultural diversity. The term biocultural diversity explicitly considers the idea that culture and nature can be mutually constituting, and denotes three concepts: first, diversity of life includes human cultures and languages; second, links exist between biodiversity and cultural diversity; and third, these links have developed over time through mutual adaptation and possibly co-evolution (Díaz *et al.*, 2015a). Toledo (2001, 2013) encapsulated these ideas into the biocultural axiom: recognition that biological and cultural diversity are mutually dependent and geographically coterminous. Globally, co-occurrence between linguistic and biological diversity is high; for example, mapping places on gradients of plant species diversity and linguistic diversity provides an interesting visual representation of an aspect of these inter-relationships (Loh and Harmon, 2005, 2014) **(Figure 5-4)**. The relationships between language and biodiversity are of course much more complex than presented in this map — and include for example hybrid cultural landscapes and knowledge systems, and processes of innovation and adaptation as discussed above (Brosius and Hitchner, 2010). Nevertheless, 70% of the world's 6,900 languages occur in the 35 remaining

FIGURE **5-3**

Location of Case examples and other features referred to in Chapter 5



biodiversity hotspots and five high biodiversity wilderness areas globally, suggesting that cultural practices of the speakers of particular indigenous languages tend to be compatible with high biodiversity (Gorenflo *et al.*, 2012). Local communities also play key roles in shaping and maintaining agrobiodiversity, including through fine-scale geographical variations in management related to cultural identity, seed exchange, use of locally-adapted landraces, women's networks to exchange cultivars for specific culinary practices, and adherence to traditional foods for daily consumption (Padmanabhan, 2011; Velásquez-Milla *et al.*, 2011; Botelho *et al.*, 2012; Calvet-Mir *et al.*, 2012; Skarbo, 2015).

Worldwide, local and indigenous cultures have developed unique biocultural associations with pollinators through multiple management, social and farming practices and in the process developed an intrinsic knowledge of their biology and ecology (Quezada-Euán *et al.*, 2001, Stearman *et al.*, 2008). People and communities of interest in industrialized urban settings also interact with pollinators, for example through keeping bees, and running community gardens (Ratnieks and Alton, 2013). Pollinators have become part of biocultural diversity around the world, even in human-dominated contexts such as cities. Claude Lévi-Strauss' (Lévi-Strauss, 1966) analysis of South American mythology of pollinators describes biocultural associations with the diversity of ecosystems. Minute attention to species diversity and habits makes them, as Lévi-Strauss (Lévi-Strauss, 1962) famously put it, not only food for eating but also food for thought **(Case example 5-1)**.

CASE EXAMPLE **5-1**

BIOCULTURAL CONNECTIONS "FROM HONEY TO ASHES"

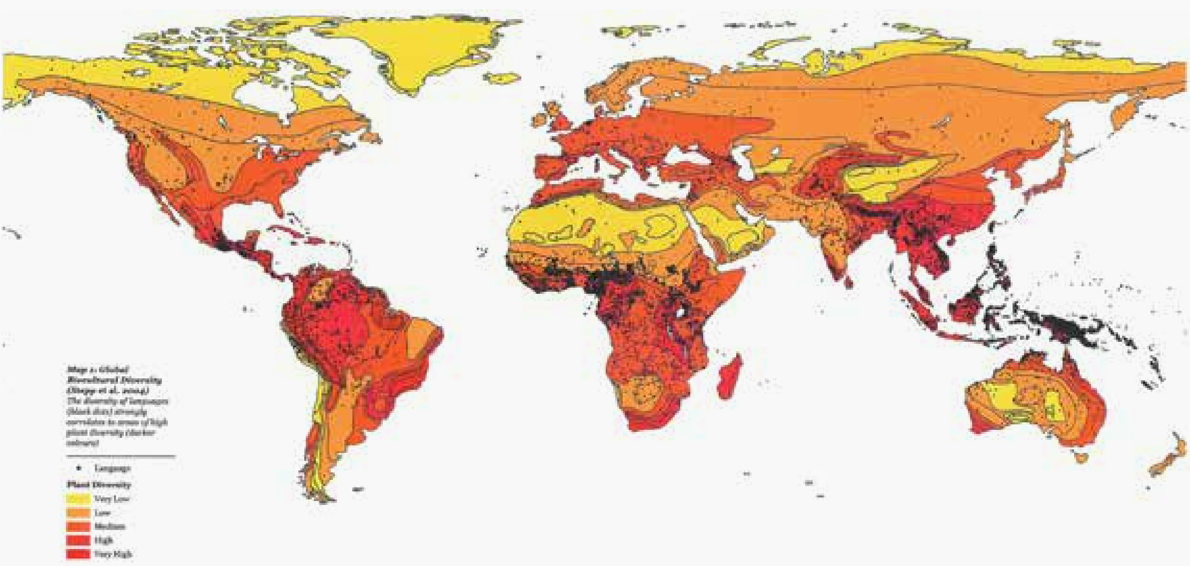
Location: South America

Indigenous people of the South American lowlands (Lévi-Strauss, 1966)

The second volume of Lévi-Strauss´ Mythologiques, titled "Du miel aux cendres" ("From Honey to Ashes") (1966) analyses several dozen myths where honey or bees are present. These myths cover a very large and diverse range of South American lowland indigenous biocultural areas, among them the Chaco, Central Brazil Gê-speaking people, Amazonian tupi-speakers and Arawak-speakers in the Guyana shield. Lévi-Strauss' analysis shows how transformations of these myths, as they travel from one region to another, use an intimate knowledge of biological, climatic and ecosystem specificities. For example, a set of myths, many versions of which were recorded in the Chaco and in Central Brazil, tells the story of a young woman who craved for honey and espoused woodpecker (Family Picidae) master of honey. This position attributed to the woodpecker in several Gê-speaking societies is based on the observation of the extraordinary techniques and stratagems this bird uses for capturing bees' larvae.

FIGURE **5-4**

Linguistic diversity and plant diversity map. Source: Loh and Harmon (2014).



5.1.4 Diversity of methods for eliciting values

Values are influenced by the worldviews in which they are grounded, shaped by the social exchanges of everyday life, the power relations, histories and geopolitical interactions of the time (Brondizio *et al.*, 2010). The term value is defined by Díaz *et al.*, (2015) to be "those actions, processes, entities or objects that are worthy or important (sometimes values may also refer to moral principles)" (pg. 13). This definition recognises at least two meanings of value that are important for IPBES assessments — the importance, worth or usefulness of actions, processes, entities or objects, and human-held values, principles or moral duties (Díaz *et al.*, 2015). Societies, groups and even individuals determine what is detrimental, beneficial or value neutral, according to their diverse contexts and perspectives. Values are culturally constructed and contextualized, reflecting diverse and dynamic knowledge systems, and lead to differences in behaviours, interactions and institutions (Brondizio *et al.*, 2010; Descola, 2014).

The IPBES conceptual framework recognises the distinction between intrinsic values, i.e., inherent to nature, independent from any human considerations of its worth, importance, or benefits to people; and anthropocentric, including instrumental and relational values, associated with provision of benefits to people for a good quality of life through both uses and relationships. Intrinsic values of nature acknowledge people as part of the web of life with a relatively recent role in the evolutionary history of life on Earth (Sandler, 2012; Hunter *et al.*, 2014). This separation does not hold in world views of most Indigenous peoples and local communities, who do not recognise a nature-people dichotomy, viewing spiritual presences of people as present in the world from time immemorial.

Diverse valuation methods in the biophysical, economic, socio-cultural, health and holistic domains can elicit and characterise intrinsic, instrumental and relational values through both quantitative and qualitative measures (Martin-López *et al.*, 2014; Raymond *et al.*, 2014; IPBES, 2015; Pascual and Balvanera, 2015). Here we address both socio-cultural and holistic valuation, first of aspects of nature's benefits to people, and then of good quality of life, dependent on pollination and pollinators (Tengberg *et al.*, 2012). While a health valuation is beyond the scope of the chapter, we do pay attention to aspects of nutritional health. We conclude this introduction with a brief summary of how socio-cultural and holistic valuations are undertaken, in recognition that valuation methods shape and articulate values, operating as informal institutions that influence diverse behaviours and perceptions (Gómez-Baggethun *et al.*, 2014; Martin-López *et al.*, 2014; Vatn, 2005). We therefore refer to valuation methods as value-articulating institutions.

5.1.5 Sociocultural and holistic valuation

Because of the multiple concepts and dimensions of nature's values, any socio-cultural or holistic valuation of biodiversity and ecosystem services is relative to a given individual or group of people, in both industrialised and indigenous contexts (Turner *et al.*, 2003). A first critical step for valuation of pollination is actors' identification, through questions such as: whose quality of life and usage of nature's benefits to people depends directly on pollinators and pollination? For whom are pollinators and pollination indirectly important? Who would be negatively affected if pollination would decline? Whose practices are influencing pollinators' populations? What is happening to the environment, landscape, agroecosystem, pollinators and pollination processes as a result? (Reed *et al.*, 2009; IPBES, 2015).

Socio-cultural valuation approaches to find answers to these questions can be viewed as varying across two dimensions: self-oriented to other-oriented (Chan *et al.*, 2012b) and individual to collective **(Figure 5-5)**. Ethnographical methods such as secondary and documentary data analysis, participant observation and interviews (e.g., formal, semi-structured) are widely used in socio-cultural valuation, with particularly relevance to collective preferences (IPBES, 2015; Scholte *et al.*, 2015). Individual preferences methods require the individual to articulate his/her values according to a consistent logic and specific rationality and reflect pre-analytic conceptions. Individual preferences can be assessed through surveys and interviews, rankings of preferences, multi-criteria analyses, Q-methodology, photo-based or valuation through visual perception elicitation time-use studies, documentary analysis and citizen science tools such as mobile applications (Christie *et al.*, 2012; Brooks *et al.*, 2014; IPBES, 2015). Most of these methods can be used to elicit both self-oriented (for personal well-being) and other-oriented (for societal well-being) values.

Valuation by deliberative methods elicits values through social processes, based on communication and collective debate (Raymond *et al.*, 2014). Deliberative methods often aim to assess values while achieving consensus through a process of reasoned discourse, but can also highlight distinct value-choices and trade-offs, such as through participatory scenario planning (Habermas, 1987; Carpenter *et al.*, 2006). Deliberative methods can involve substantial transaction costs and be challenged by power and knowledge asymmetries (Hill *et al.*, 2015a). Deliberative methods include citizen juries, forums, workshops, focus groups, participatory scenario planning, participatory GIS, collective preference ranking, participatory and rapid rural appraisal, role-playing games and Delphi panels (Chambers, 1981, 1994; Susskind *et al.*, 1999; Pert *et* *al.*, 2013). Valuation methods involve a combination of quantitative, qualitative and mixed methods approaches to data collection and analysis (Creswell, 2014; Kelemen *et al.*, 2014).

Socio-cultural valuation can capture potential impacts such as loss of psychological benefits from viewing pollinators such as butterflies and bees (Kumar and Kumar, 2008; Hanley *et al.*, 2013). Socio-cultural evaluation helps identify how and why different values are relevant for different people; within different times (e.g., seasons) and places; to recognize perceived trends as an early warning of ecosystems deterioration; to reveal intangible values; to explore how these values relate one with the other (e.g., in bundles) and to quality of life; to reveal trade-off options; to integrate different forms of knowledge and to detect power asymmetries and potential social conflicts related to different perceptions, needs and use (Chan *et al.*, 2012a; Plieninger *et al.*, 2013; Martin-López *et al.*, 2014; Oteros-Rozas *et al.*, 2014; Scholte *et al.*, 2015).

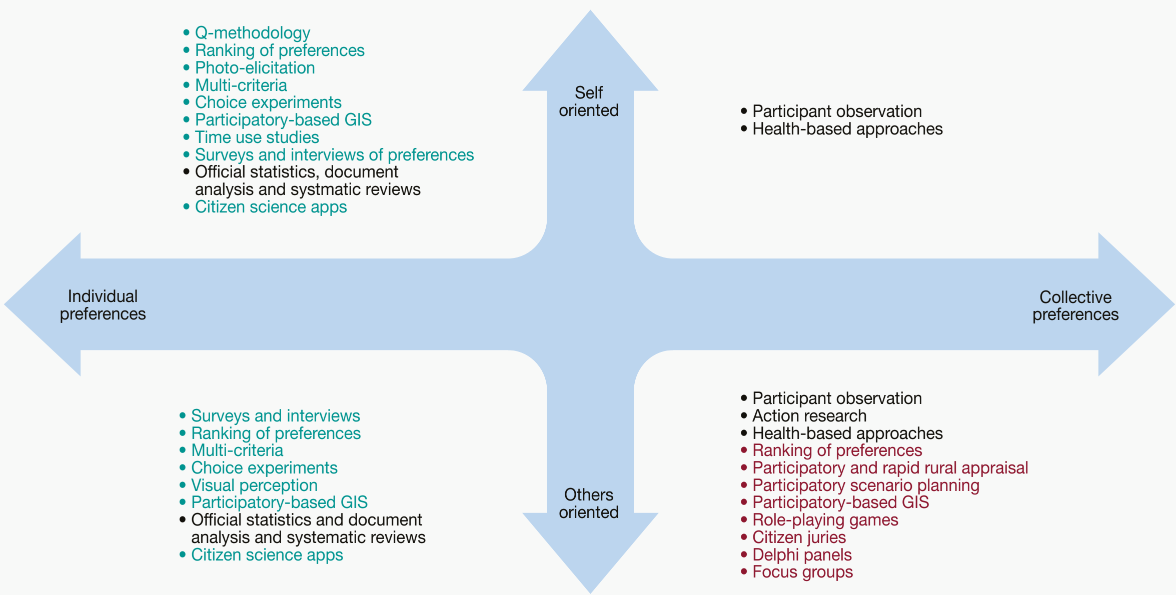
Holistic valuation methods are closely aligned to socio-cultural valuation approaches, and use many of the same deliberative other techniques (IPBES, 2015). The central feature that distinguishes holistic approaches is their internalization of the world views of indigenous peoples and local communities (Quaas *et al.*, 2015). The IPBES Conceptual Framework provides that pairing different value systems with different valuation approaches and techniques is important to providing integrated understandings of nature's benefits to people, and contributions to good quality of life (Díaz *et al.*, 2015a). The diversity of Indigenous peoples' and local communities' (IPLC) values systems challenges an easy pairing between valuation approaches and value systems (IPBES, 2015). Nevertheless, two features among ILK systems are commonly encountered as introducing complexity into conventional socio-cultural valuation approaches.

The first feature in ILK systems is the emphasis on the interconnectedness and multiple relationships between people and nature, reflected in concepts such as totems, kin groups, sacred sites, ancestral landscapes, numina and taboo relationships (Berkes, 2012; IPBES, 2015). Cultural values are seen to vary spatially and temporally with the dynamics of these social relations — for example, Aboriginal people in central Australia attribute the wave of mammal extinction to the decline of their ceremonies for those animals (Rose, 1995; IPBES, 2015; Jackson and Palmer, 2015; Pert *et al.*, 2015). Socio-cultural valuations approaches more frequently consider how the diverse social groups assign different values to various parts of the landscape, resulting in values varying spatially with the dynamism of the environmental attributes, and the concept of cultural ecosystem service hotspots (Raymond *et al.*, 2009; Martínez Pastur *et al.*, 2015).

FIGURE **5-5**

Synthesis of socio-cultural valuation methods. (Based on Chan *et al.*, 2012a and b, Christie *et al.*, 2012, and Kelemen *et al.*, 2014).

Methods in blue are the consultative ones; methods in red are deliberative; and in black are other types of methods.



The second feature is the ongoing stories and life-ways through which relationships are forever alive and dynamic, continuously weaving together and co-creating the world (Ingold, 2011; Jackson and Palmer, 2015). Socio-cultural valuation methods typically are based on concepts of a place, such as a wetland, being perceived and hence valued in different ways by multiple stakeholders, rather than being co-created manifestations (Martin-López *et al.*, 2014).

Holistic valuation methods are oriented to indigenous peoples' and local communities' own logics; particular examples include the Māori Wetland Indicators (Harmsworth *et al.*, 2011) and the Salish environmental health indicators (Harmsworth *et al.*, 2011). Jackson and Palmer (2015) argue that valuing practices and ethics enables the "possibility of understanding ecosystem services in ways which make legible and enhance the possibility of recognizing, building and expanding upon the reality of indigenous social tenures and reciprocal social relations" (pg. 18). Holistic valuation approaches are used here to give the special emphasis on the experience of indigenous and local communities required by the chapter scope, through a focus on relevant practices based on ILK.

5.2 POLLINATORS, POLLINATION AND NATURE'S BENEFITS TO PEOPLE

5.2.1 Natures's benefits to people, good quality of life and categories of values

While typologies of values are always somewhat artificial — values can be categorized in many different ways in response to dynamic human cultures, and social-ecological interactions — they are useful to valuation (MEA, 2005; Tengberg *et al.*, 2012). From the socio-cultural valuation perspective, pollination and pollination-dependent products contribute to the delivery of provisioning services, such as food, medicine, construction materials and items of technology (e.g., musical instruments); and provide cultural services such as recreational and educational activities with and for pollinators (gardening, ornamentals, learning from beekeeping), and as a source of inspiration, including through the use of natural motives of artefacts in art, folklore, sacred, religious, technological and other forms of inspiration **(Table 5-1)**.

TABLE **5-1**
Nature's benefits to people and categories of value in this assessment

Category	Type of values	Focus of values	Categories used in this assessment
Nature's benefits to people	Instrumental	Ecosystem goods and services (socio-cultural valuation)	Provisioning services: Food, medicine, construction materials, technology (e.g musical instruments)
			Cultural services: Recreational and education (activities with and for pollinators); inspirational (use of natural motives or artefacts in art, folklore, sacred, religious, technological and other forms of inspiration)
		Nature's gifts (holistic valuation)	Practices gifted to indigenous peoples and local communities: the practices of valuing diversity and fostering biocultural diversity; landscape management practices; diverse farming systems; innovation

TABLE **5-2**
Good quality of life and categories of value in this assessment

Category	Type of values	Focus of values	Categories used in this assessment
Good quality of life	Relational	Heritage (socio-cultural valuation)	Both tangible and intangible relationships between people, pollinators and good quality of life
		Aesthetics (socio-cultural valuation)	Appreciation of natural and cultivated landscapes and species
		Identity (socio-cultural valuation)	Group and individual identity linkages with pollinators
		Livelihoods (holistic valuation)	Derived from relationships between ILK-holders, pollinators and pollinator-dependent products
		Social Relations (holistic valuation)	Song, dance, art, story, rituals and sacred knowledge associated with pollinators and pollination
		Governance (holistic valuation)	Governance by, with and for pollinators

From the holistic valuation perspective, nature's benefits to people fit key categories of nature's gifts to indigenous peoples and local communities in the form of practices of supporting diversity and fostering biocultural diversity, in landscape management practices, diversified farming systems, innovation and adaptation. While many practices and ethics outside of indigenous peoples and local communities could also be considered as nature's gifts, the scope of this assessment did not extend to investigating this dimension.

The categories considered for good quality of life include a range of values that overlap to some extent with those that comprise nature's benefits to people **(Table 5-2)**. For example, quality of life categories include the livelihoods of indigenous peoples and local communities that derive from relationships between ILK-holders, pollinators and pollinator-dependent products, including income, food and medicines. While these can also be viewed as aspects of provisioning services, and part of nature's benefits to people, from the perspective of ILK systems, they fit better with concepts of good quality of life (Díaz *et al.*, 2015). Pollinators support numerous other categories of value that contribute to good quality of life including heritage, aesthetics, identity, social relations and governance attributes. These relational values are assessed in section 5.3.

5.2.2 Provisioning ecosystem services (socio-cultural valuation)

Provisioning services include the pollination of plants, and the use of pollinators themselves, for food and medicine production, pollinators' products such as honey and wax used in objects (e.g. fine musical instruments), and pollinator-dependent construction materials, biofuels and fibre (Krell, 1996; Quezada-Euán *et al.*, 2001).

Many foods and medicines are derived from pollinators and pollinator-dependent resources (Costa-Neto, 2005; Cortes *et al.*, 2011; Eilers *et al.*, 2011; Rastogi, 2011). Around 2,000 insect species are consumed as food globally, including many that are pollinators such as the larvae of beetles, moths, bees, and palm weevils, in both developing and developed world contexts (Jongema, 2015). Insects are now being recognised as potentially important for food security, being high in protein, vitamins and minerals (Rumpold and Schluter, 2013; van Huis, 2013). In Fiji, trees providing fruits for human consumption include coconut (*Cocos nucifera*) and lilly-pilly (*Syzygium* spp.), both pollinated by bats (*Notopteris macdonaldi*, *Pteropus samoensis*, and *Pteropus tonganus*) (Scanlon *et al.*, 2014). Durian (*Durio zibethinus*), a popular and economically high-return fruit throughout southeast Asia, with rich bioactive and nutraceutical properties, relies primarily on pollination by bats (e.g. *Eonycteris spelaea*) (Bumrungsri *et al.*, 2009; Ho and Bhat, 2015) **Figure 5-6**. Crop plants that depend fully or partially on animal pollinators are important sources of vitamin C, lycopene, the antioxidants beta-cryptoxanthin and beta-tocopherol, vitamin A and related carotenoids, calcium and fluoride, and a large portion of folic acid available worldwide (Eilers *et al.*, 2011).

Bees and their products (venom, honey and wax) have been used since Ancient Greek and Roman times in curing everything from bladder infections to toothaches and wound recovery (Weiss, 1947; Krell, 1996). Scientific and technological development of bee products such as propolis (the resin collected by honey bees from tree buds, used by them as glue) and honey continue to yield medicinal and pharmacological products and uses, including as anti-diabetic agents (Banskota *et al.*, 2001; Amudha and Sunil, 2013; Begum *et al.*, 2015; Jull *et al.*, 2015). Honey is anti-bacterial, anti-viral and anti-fungal, and all of these properties make it ideal for healing wounds (Kumar *et al.*, 2010). Bee products, primarily honey, are currently used to treat, among other illnesses, multiple sclerosis, osteoarthritis, rheumatoid arthritis, post-herpetic neuralgia, coughs, herpes simplex virus, premenstrual syndrome, sulcoplasty, allergic rhinitis, hyperlipidemia, the common cold, and topically for burns, wound healing, diabetic foot ulcers and for improving athletic performance (Gupta and Stangaciu, 2014). Stingless bees' honey is widely used for medicinal purposes by indigenous peoples and local communities, in regions where they are distributed, as integral parts of their livelihood systems (Massaro *et al.*, 2011).

FIGURE **5-6**

Flowers of durian, a high-value tropical fruit, and their bat pollinator (*Synconycteris australis*) in north Queensland, Australia. © Barbara & Allen at Wild Wings & Swampy Things Nature Refuge. Reproduced with permission.

Several musical instruments depend on the provisioning services of pollinators. Propolis is an important ingredient of the varnish used on high-quality stringed instruments (Lieberman *et al.*, 2002; Stearman *et al.*, 2008). Bees' wax is an essential ingredient in Asian mouth organs, which originated in what is now Laos more than 3,000 year ago, and have diversified into different forms in China (*sheng*) and Japan (*shô*) (Peebles *et al.*, 2014). Historically, ethnic groups in many countries have a great variety of musical instruments from gourds, which are fruits of pollination. The wax of native bees play a very important role in pre-Colombian Amerindian cultures, (Patiño, 2005) and especially in metallurgic activities, through a technique to produce pieces of metalwork. The Amerindian silversmiths produced gold pieces with the method known as "drain to the lost wax". The cerumen was used to produce a mould of a model of the piece they want, and after several processes, the cerumen was replaced by gold to obtain the finely-crafted object which faithfully reproduces every detail on the surface of the original model (Falchetti, 1999). Lost-wax casting using bees' wax dates back to copper objects found in Israel between 3500-3000 BC (Crane, 1999) **(Figure 5-7)**. In western Colombia, the propolis of "brea bees" (*Ptilotrigona occidentalis*) called *canturron* was used on torches for lighting and for waterproofing boats and as healing of minor wounds (Galvis, 1987; Nates-Parra, 2005; Patiño, 2005). Cerumen and wax are also critical ingredients in traditional bows and arrows, and contemporary tourist versions of these in the Bolivian Amazon (Stearman *et al.*, 2008). Beeswax has long been an ingredient of surfboard wax, and is resurging in response to interest in eco-friendly products (Falchetti, 1999; Chioi and Gray, 2011).

Pollination is also critical for ensuring availability of other useful materials such as biofuels (e.g., *Jatropha curcas*), fibre (e.g., cotton) and construction materials ls (e.g., *Eucalyptus* spp.). The biofuel crop Jatropha oil (*Jatropha curcas*) has highest overall yield and quality under natural pollination by bees (Romero and Quezada-Euán, 2013; Negussie *et al.*, 2015). Maintaining communities of pollinators enhances production on cotton farms, especially in organic production (Pires *et al.*, 2014). Eucalyptus spp. and other tree species important for construction rely on animal pollination (Pavan *et al.*, 2014).

FIGURE **5-7**

Drain to the lost wax: Gold pieces produced (Pre-Columbian) by Amerindian cultures with this technique using the wax of stingless bees. © Banco de la Republica de Colombia. Reproduced with permission.

A) Wax Molds; B) Quimbaya Poporo (Pre-Columbian) C) Muisca Raft ceremonial.

A

B

C

5.2.3 Cultural ecosystem services: sources of inspiration (socio-cultural valuation)

Pollinators, particular bees, have long been a source of inspiration for art, literature, folklore and religion (de Gubernatis, 1872; Andrews, 1998; Kristsy and Cherry, 2000; Bastian and Mitchell, 2004; Werness, 2006). Rock art of honey bees has been identified at 380 separate sites in 17 countries across Europe, Africa and the Indian sub-continent, showing 25 representations of honey harvesting or associated activities (Crane, 2001, 2005) **(Figure 5-8)**. The earliest records come from rock art in southern Africa dated to 10,000 years ago, with some sites possibly older, and in Europe dated to 8,000 years ago (Crane, 1999; Lewis-Williams, 2000). The wax from honey bees was used to preserve the colors of ancient wall paintings more than 2000 years ago in central Asia and Crimea (Birshtein *et al.*, 1976).

Art associated with 'sugarbag dreaming', the term for sacred stories, ceremonies and other practices associated with stingless bees among Aboriginal Australians, is common in both rock-art sites and contemporary bark and other media paintings (Morphy, 1991; Prideaux, 2006) **(Figure 5.9 A)**. Rock art with beeswax, although relatively young in Australian terms, is commonly used for dating in that continent; the oldest beeswax figure known from Australia is a turtle motif dated from 4000-4500 BP, at Gunbilngmurrung, Northern Territory (Langley and Taçon, 2010).

Pollinators, particularly bees, are also inspirations for many sacred and religious traditions, including within Islam, Christianity, Hinduism, Buddhism and traditional Chinese teachings. For example, the coat of arms of Pope Urban VIII, Maffeo Barberini, features three bees as the central symbol, which can be found in various ornamentations including the fresco ceiling of the Barberini Palace (National Museum of Art), painted to celebrate his Papacy, parts of the Vatican building and Saint Peter's Basilica (Hogue,

FIGURE **5-8**

Rock art of bee-hunting. Mesolithic (c. 10,000/8000–c. 3000 bce). Cueva de la Arana, Spain. © Museum of Prehistory, Valencia, Spain. Reproduced with permission.

2009) **(Figure 5-9 B)**. Moroccan and many other societies' interactions with bees and honey today are guided by the religious principles set out in the Qur'an, the sacred text of Islam, which includes a passage devoted to bees, the *Surat An-Naĥl* (Adam, 2012) **(Figure 5-9 C)**. Chuang Tzu (Zhuangzi), a defining figure in the religious traditions of Chinese Taoism, writes of the blurred distinction between a man dreaming of being a butterfly, or a butterfly dreaming of being a man, symbolising spiritual transformation of the material (Wu, 1990). In Buddhist text and teaching, bees and pollinators symbolize the enactment of compassionate and conscious living (NAPPC Faith Task Force, 2012). Many of the foundational texts of Hinduism feature pollinators and pollination **(Case example 5-2)**.

CASE EXAMPLE **5-2**

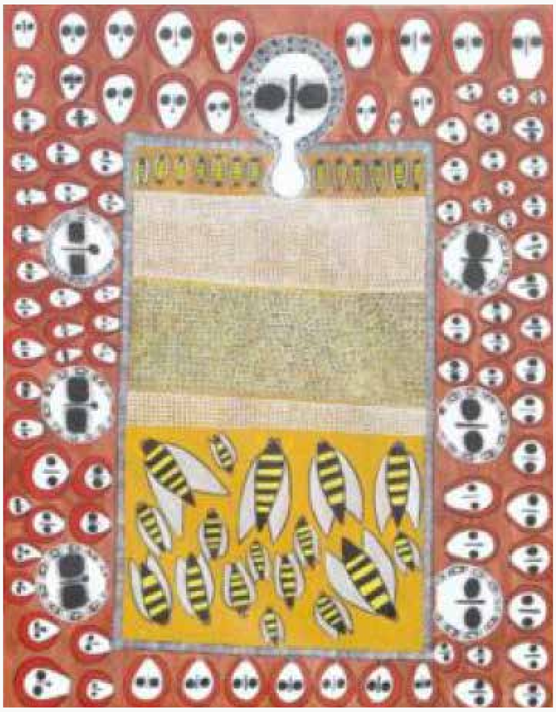
SACRED TEXT ON FLOWER MORPHOLOGY, POLLINATORS AND POLLINATION FROM INDIA
Location: India
Many different communities over millennia

Studies have shown that pollination and pollinators have been an important part of Asian culture and religious traditions for centuries (Joshi *et al.*, 1983). In Asia, India has the most ancient written records of association between humans, pollination and pollinators. Ancient literature (circa 1700-1100 BCE) that comprises the sacred texts of Hinduism — the Vedas (poems and hymns), Upanishads (sacred treatises), the Puranas (sacred writings) — and major Sanskrit epics like Mahabaratha and Bharatayudaall, all contain information on flower morphology, pollinators and pollination (Belavadi, 1993). Several rock paintings in caves in Central India depicting beehives and honey collection show that pollination and pollinators were already an important part of the culture since the Mesolithic era (15000-11000 BCE) (Wakankar and Brooks, 1976).

Bees are famous in literature and poetry, for example from Shakespeare's references about bees and honey in *Julius Caesar*, *King Henry IV, V* and other plays (Miller, 1948), to the prize-winning collection *The Bees* by Poet Laureate Carol Ann Duffy (Duffy, 2011). Bees and honey appear in the literary traditions from the ancient Egyptians, Romans and Greeks, in Sumeria and Babylonia, in Britain and Ireland, France, Finland, in the codices of the Mayans in central America, among the Germanic and Slavonic people of central Europe, in central and southern Asia (Edwardes, 1909; Ransome, 1937 [2004]). Bees and honey are a source of inspiration for both popular (e.g., "Tupelo Honey" by Van Morrison; "King Bee" by Slim Harpo) and traditional classical music (e.g., Flight of the Bumble bee by Rimsky-Korsakov) (Hogue, 2009).

FIGURE **5-9**

Pollinators in sacred traditional and religious art from three continents.



A) Sandra Mungulu (b.1960), 'Wandjina and Waanungga' acrylic on canvas. Australia. © Sandra Mungulu/Licensed by Viscopy, 2015.

Artist Sandra Mungulu explains, "Waanungga is a word for various forms of bush honey, 'sugarbag', found in trees and termite mounds. The Wandjinas (ancestral beings from the dreaming, present in the landscape today) keep the countryside fresh and healthy which allows the native bees to produce high quality honey. My mother is called 'Guduwolla', the Ngariniyin name of a particular tree which produces white pollen in early summer, and is the main source of sugar bag in the Kimberley region of north-west Australia".

B) Three-bee centrepiece of Pietro da Cortona's Ceiling of the National Gallery of Ancient Art at Palazzo Barterini, Rome. Europe. © Ministero per i Beni e le Attivita Culturali. Reproduced with permission.

The Barberini coat-of arms features the 3-bumblebee crest and appears in the centre of Pietro da Cortona's Ceiling, painted to celebrate Cardinal Meffio Barberini becoming Pope Urban VIII, celebrating divinity. This 3-bee crest appears in the Vatican and St Peter's Basilica.

C) Celebrating pollinators in Islamic Art: Chinese Export Rose Canton porcelain produced for the Persian market, China, Qing Dynasty 1875 AD / 1292 AH.

This porcelain dish, celebrating fruits, leaves, insects, birds, roses, flowers and the nightingale, was commissioned in 1875 AD / 1292 AH for personal use or as a royal gift. Rose Canton porcelains were praised in Iran for their colourful and cheerful composition, bright, meticulous execution and lustrous glitter. The inscribed Persian poem reflects the merry atmosphere with a deeper meaning, contemplating a meditative state, important in Islam. © Islamic Arts Museum Malaysia, 2016. Reproduced with permission.

Bees in general are a source of inspiration for technological development, for example in relation to visually guided flight and robotics (Srinivasan, 2011; Sun, 2014). Increased opportunities to observe pill-rolling behaviour by scarab beetles following domestication of large mammals in the Middle East has been identified as a source of inspiration for the invention of the wheel (Scholtz, 2008). Amateur entomology (particularly centered on the pollinators butterflies and beetles) is extremely popular in contemporary Japan and has inspired development of thirty-foot telescopic nets, and bug-collecting video games (Kawahara, 2007).

Native bees are the source of inspiration for contemporary art and wildlife photography, as evidenced by enormous popularity of the USGS Native Bee Inventory and Monitoring Web-site showing high-resolution and close-up photos (Droege, 2010). Canadian artist Aganetha Dyck[3] co-creates delicate sculptures with bees by leaving porcelain figurines, shoes, sports equipment, and other objects in specially designed apiaries where they are slowly transformed with the bees' wax honeycomb (Keshavjee, 2011); she won the Canadian Governor General's Award in Visual and Media Arts in 2007. The Pollinator Pathway® is another award-winning example, developed from participatory art, design, ecology and social sculpture by artist Sarah Bergman to promote ecological corridors for pollinators in urban spaces (Bain *et al.*, 2012). Bergman (2012) now offers certification for others creating such pathways. Bees are a source of inspiration for public and community art. In London, UK, for example, street artists promote the conservation of bees through murals and graffiti; and the annual community mandela project in British Columbia celebrated bees in 2013 **(Figure 5-10)**.

3. http://www.aganethadyck.ca/

5.2.4 Cultural ecosystem services: recreational and educational values of beekeeping (socio-cultural valuation)

Honey bees and beekeeping are highly valued as recreational activities (Gupta *et al.*, 2014). Tierney (2012) found that rural beekeeping was an effective intervention tool for reducing recidivism (i.e., relapse in criminal behaviour) among youth, increasing their self-esteem, confidence, the ability to learn and the frequency of social interactions. In Greater London, the number of beekeepers

FIGURE **5-10**

Public art inspired by bees.

A) Save the bees project in London, United Kingdom. © Louis Masai Michel. Reproduced with permission.

B) Mandela with bees in British Columbia, Canada. © Roberts Creek Community Mandela. Reproduced with permission.

tripled from 464 to 1,237, and the number of hives doubled from 1,677 to more than 3,500 between 2008 and 2013, leading to concerns that there were insufficient floral resources to keep bees healthy (Ratnieks and Alton, 2013). In Germany, the number of beekeepers has increased by 53% since 2012, and bee-keeping has emerged as a popular ecologically-inspired urban lifestyle phenomenon, alongside growing markets for locally-produced honey (Lorenz and Stark, 2015).

In Sargodha and Chakwal districts of Pakistan, beekeeping activities teach and educate the communities about the values of cooperation in life (Qaiser *et al.*, 2013). Beekeeping activities pass on knowledge about pollination for the youth and rural people in India (Sharma *et al.*, 2012). The Bee Hunt! Program in the USA involves students across the nation in photographing bees, uploading spatially-located observations and photos to a data-sharing Internet site, enabling understanding of bee distribution relative to drivers such as pesticides, and provides resources to empower them to take action to solve bee problems through technology, education and policy advocacy (Mueller and Pickering, 2010). Beekeeping can also lead to new knowledge. For example, one Spanish beekeeper has found that a moth species, *Galleria mellonella*, regarded as plague for bees, is actually an ally that cleans spores and microorganisms from the hives (Santoja, 2005).

5.2.5 Nature's gift: practices of ILK-holders and their extent of influence (holistic valuation)

Global data on the extent of the Earth's surface under ownership, management and use by indigenous peoples and local communities, are not yet available, a key knowledge gap that needs to be addressed for ongoing biodiversity and ecosystem service assessment. Available data suggest ILK systems provide the foundation for ongoing conservation, management and use of ecosystems over large parts of the planet (Chhatre and Agrawal, 2009; Gómez-Baggethun and Reyes-García, 2013; Kelemen *et al.*, 2013). For example, the area of forests owned by, or designated for, indigenous peoples and local communities in Lower and Middle Income Countries (LMIC) has increased from 21% in 2002 to 30% in 2013 as rights-recognition has strengthened in some countries. (White and Martin, 2002; Rights and Resources Initiative, 2014). Kothari *et al.* (2012) estimate that Indigenous and Community Conserved Areas[4] may cover as much as 13% of the Earth's terrestrial surface. Indigenous peoples number around 370 million, and live in all regions of the world (Secretariat of the United Nations Permanent Forum on Indigenous Issues, 2014). Nevertheless, many communities are losing land they have occupied for centuries or millennia because of limited recognition of their rights (van Vliet *et al.*, 2012; Rights and Resources Initiative, 2014; Césard and Heri, 2015; Perez, 2015; Samorai Lengoisa, 2015).

Among local communities, part of the 55% of global population who are rural, many are farmers (IFAD, 2011). Small holding farmers in local communities hold knowledge adapted to understanding and managing local ecologies and land capabilities, including of soil fauna and properties, tree dynamics and genetic diversity, landscape-scale vegetation patches, crop diversity, livestock resources and agroforestry species (Netting, 1993; von Glasenapp and Thornton, 2011; Gao *et al.*, 2012; Pauli *et al.*, 2012; FAO, 2014a; Segnon *et al.*, 2015; Valencia *et al.*, 2015). Small holdings (less than 2 ha) constitute 8-16% of global farm land, 83% of the farms and 83% of the global population involved in agriculture (IFAD, 2013; Lowder *et al.*, 2014; Steward *et al.*, 2014).

5.2.6 Practices for valuing diversity and fostering biocultural diversity of stingless bees and pollination resources in central and South America

Many indigenous peoples are known to value diversity in itself, to appreciate the existence of many different living and non-living entities as important (Tsing, 2005; Rival and McKey, 2008). This translates into recognizing and naming very fine distinctions in domains such as landscapes, wild species and cultivated varieties. Observations of these distinctions enable Indigenous peoples and local communities to collect, experiment and select varieties and species. Indigenous peoples in central and south America domesticated many pollinator-dependent crops that are now cultivated globally, including legumes (common bean, lima beans, peanut), cucurbits (chayote, pumpkins, squash), solanaceous fruits (capsicum peppers, husk tomato, pepino, tomato), fruits and nuts (blueberry, brambles, cactus pear, cashew, papaya, pineapple, strawberry), beverage crops (cacao, mate), ornamentals (dahlia, fuchsia, sunflower), industrial crops (cotton, rubber, tobacco), tubers (cassava, potato, sweet potato) and pineapples whose seed production requires pollination (Janick, 2013). This valuable diversity translates into a wide array of connections (relational values) with a wider array of pollinators and their products, including honey, pollen, resins, and oils. For example, the Wayapi people of Guyana and Brazil recognise 17 different varieties of honey that each come from a different stingless bee species, each with a specific name (Grenand, 1972).

4. Indigenous and Community Conserved Areas (ICCAs) have been defined by IUCN as 'natural and/or modified ecosystems, containing significant biodiversity values, ecological benefits and cultural values, voluntarily conserved by indigenous peoples and local communities, through customary laws or other effective means' (Kothari *et al.*, 2012).

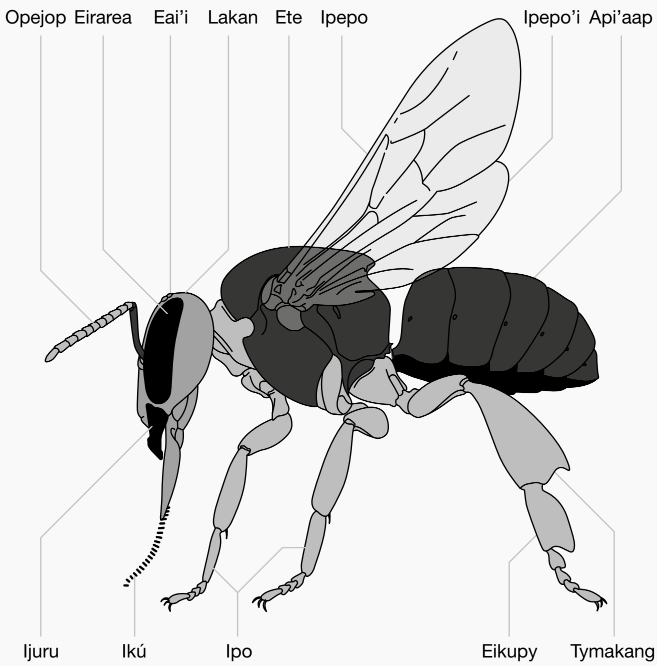
Latin Amerindian knowledge of stingless bees is particularly strong. In Colombia, Nates-Parra and Rosso-Londoño (2013) recorded nearly 50 common names used for the stingless bees, with wide variation among regions and informants. Common names do not always correspond one-to-one with scientific names, and such locally recognized entities are termed ethnospecies, which can match, under-differentiate or over-differentiate compared to scientific species (Otieno *et al.*, 2015). Detailed knowledge exists of at least 23 ethnospecies among the Hoti people in Venzuela; 25 bee ethnospecies among the Tatuyo, Syriano and Bara peoples of Colombia and the Guarani-Mbyá people of Argentina, Brazil, Paraguay; of around 43 different bee ethnospecies among Nukak people of northwest Amazon; of 48 bee ethnospecies among the Enawene-Nawe people of southern Brazil and 56 bee ethnospecies among the Gorotire-Kayapo in northeastern Brazil (Posey, 1983a; Cabrera and Nates-Parra, 1999; Rodrigues, 2005; Rosso-Londoño and Parra, 2008; Santos and Antonini, 2008; Estrada, 2012; Rosso-Londoño, 2013). Kaxinawa and Gorotire-Kayapo, as well as many other indigenous peoples, understand nest architecture in detail, naming external and internal parts, as well as the various parts of the bee, a remarkable feat without microscopes, reflecting the strategy of close observation that is so critical to their fostering of pollination and pollinator diversity (Posey, 1986; Camargo and Posey, 1990; Oliveira, 2001). Kawaiwete peoples' close observation extend to fine detail of pollinator-relevant structures, such as the pollen basket **(Figure 5-11)** (Villas-Bôas, 2015).

Kayapo have specific names for each larval and pupal instar of the stingless bee, and the colony sociality and organization of labor helped to build their imagery, inspiring their social life in the tribe. In addition, the Gorotire-Kayapos developed an ability to locate bees nest by listening to the noise from nest ventilation, which they recognized for each bee species. At night, shamans walk in the forest to locate bee nests. Other Amerindians used to follow the odor that bees used to mark nesting sites. Insects, especially bees, ants and wasps, are of great practical and symbolic importance for the Andoke people (Colombian Amazon forest). They are able to classify bees according to the quality of their honey, the food and nesting habits (Jara, 1996). Aggressive bees like *Oxytrigona* spp. and Apis mellifera (African bee invaders) were managed with smoke and a liana which had an effect of calming the bees to sleep, so that people could collect the honey without being harmed (Camargo and Posey, 1990).

Diversity in bees is celebrated in many stories (e.g., **Case example 5-3**). An Ofaié-Xavante myth talks of a time when animals and people were not distinct and honey came from a single cultivated plant. But the master of animals found it more reliable to confine production

FIGURE **5-11**

Morphological structure of bees as recognised by the Kawaiwete close observation techniques that underpin pollinator management. Source: Villas-Bôas (2015) (adapted from Camargo and Posey, 1990).



CASE EXAMPLE **5-3**

KAWAIWETE PEOPLES' KNOWLEDGE AND USE OF NUMEROUS STINGLESS BEES

Location: Southern Amazon, Brazil

Kawaiwete Indigenous people (Villas-Bôas, 2015)

Co-produced case example

Underpinned by direct interactions with indigenous and local knowledge-holders

Kawaiwete Indians (previously known as Kaiabi) now live in the Xingu Indian Park, in Southern Amazon. Stingless bees are under the protection of a strong entity who may well punish and inflict "bee illness" onto those who do not show proper respect and observe silence when collecting honey. Hence, as honey may carry some degree of risk, its medicinal use is not as wide as elsewhere. However, it is used for diarrhea caused by undercooked fish. Bee hives containing eggs and larvae, rather than honey itself, are used to calm fever and for rubbing children´s and young peoples´ heads in order to protect them from illness as well as for expelling harmful spirits. Expecting fathers are required to observe several rules related to bees in order to benefit both delivery and the baby´s health.

Kawaiwete have extensive knowledge of and names for 37 stingless bee species, their particular habitats, and their ecological distribution, and they identify 28 forest trees that bees use for nesting as well as 19 plant species on which they like to feed. Kawaiwete consider as edible the honey of 26 out of those 37 bee species. *Eiry,* also rendered as "honey juice", is much appreciated. It is prepared from honey occasionally mixed with bee larvae. Honey found in the forest will also be a man´s sustenance during hunting expeditions. Round pointed arrow tips are made with bees wax and serve to capture ornamental feathered birds. Wax is also extensively used for repairing calabashes. Kawaiwete are aware of the geographic distribution of different bees' species and they sorely regret no longer having access to species endemic to their former territory.

of honey to a great diversity of stingless bees, whom he unleashed into the forest. This myth interestingly praises collection in the wild over agriculture – diversity of honey in the wild is preferable to domestication (Lévi-Strauss, 1966). Indigenous lowland people in South America continue to favour their many different types of wild honey. Honey-hunting expeditions, targeting different honey at different seasons, are highly valued and most frequent in the dry season. Honey is considered exquisite food, and while it can be eaten naturally in the forest, it is mainly drunk mixed with water and bees´ larvae. Many Amazonian societies will ferment the beverage and make it into a beer; they will also mix it with several palm fruits´ juice and let it ferment (Villas-Bôas, 2015).

By their practices of favoring heterogeneity in land-use as well as in their gardens, by tending to the conservation of nesting trees and flowering resources, by distinguishing the presence of a great range of wild bees, and observing their habitat and food preferences, indigenous peoples and local communities are contributing to maintaining, fostering and co-creating an abundance and, even more importantly, a wide diversity of bee pollinators and pollination-dependent biota.

These practices extend to other pollinators. For example Ribeirinhos people from Brazil note a specific pollination connection that exists between a cockchafer and the plants *Theobroma* spp. (Couly, 2009); Bribri and Cambécar peoples in the Talamanca of Costa Rica have extensive knowledge of birds who are pollinators, with local names and narratives about their behaviours (Fernández *et al.*, 2005); and Mapuche and Yagane peoples of Chile have many narratives about hummingbirds (Rozzi, 2004).

5.2.7 Landscape management practices and fostering biocultural diversity for pollinators and pollination across the world

A wide range of ILK-holders across the world value nature's gifts of landscape management practices that foster biocultural diversity for pollinators and pollination. Relevant landscape (social-ecological) management practices include: taboos on felling bee-hive trees and pollinator-habitat forest patches (Césard and Heri, 2015); kinship relationships requiring respect and care with pollinators (Hill *et al.*, 1999; Gasca, 2005); fire management to enhance pollination by increasing floral resources (Vance *et al.*, 2004); mental maps and animal behaviour knowledge to hunt honey (Si, 2013); seasonal rotations for prolonged harvests (Titinbk 2013, Samorai Lengoisa 2015); landscape patch management (Bodin *et al.*, 2006); use of biotemporal indicators (observed changes in biological processes over time) including birds and flowering to signal the time for burning vegetation and to harvest honey (Athayde, 2015); placement of pollinator-dependent crops (e.g, cucumber) close to pollinator-rich forests (Calle *et al.*, 2010); and encouragement of bees in housing.

5.2.7.1 Taboos that protect pollinators and pollination resources

Indigenous peoples and local communities often place taboos prohibiting hunting or disturbance of animals, plants and places that extends to protection of pollination resources (Colding and Folke, 2001; Saj *et al.*, 2006; Kideghesho, 2009) **(Case example 5-4)**. For the Berawan

CASE EXAMPLE **5-4**

PRIORITISING PROTECTION OF HABITAT AND BEE HIVE-TREES IN INDONESIAN FORESTS

Location: Indonesia
Petalangan indigenous people

Petalangan is a group of indigenous people practicing hunting, fishing, and swidden agriculture, living relatively isolated at the forest margins in Riau Province, Sumatra, Indonesia. The Petalangan community view bees as a symbol of health and prosperity and the *sialang* trees, where the bees nest, as a symbol of the universe. *Sialang* is a generic term of trees that have bees nests on them and includes several species of trees: *Ficus* spp.; *Koompassia excelsa (mangaris)*; *Octomeles sumatrana*; *Artocarpus maingayi*; *Macaranga* spp.; *Koompassia malaccensis (kempas)*; and *Metroxylon* spp.

No one can cut down the *sialang* trees and all other trees surrounding the *sialang* trees. The *sialang* trees and surrounding habitat are then conserved (named as *rimba kepungan sialang*, meaning patch of forest surrounding *sialang*). The community views the trees as integral to water for the area. Petalangan people perform a ritual to keep bee trees healthy by watering the base of the tree followed by the slaughtering of chicken (3 colours) (Titinbk, 2013). Fruits are usually harvested from the forests surrounding the habitat of *sialang* trees (Buchmann and Nabhan, 1996).

CASE EXAMPLE **5-5**

SUGAR BAG DREAMING. KINSHIP RELATIONSHIPS PROTECTING BEES IN AUSTRALIA

Location: Arnhem Land, Northern Territory, Australia
Yolngu indigenous people (Fijn, 2014)

The stingless bees *birrkuda* and *yarrpany* are classified as Yirritja and Dhuwa by the Yolngu people who separate their world into two kinship groups with these names. This has led to the development of specific songs, dances and power names associated with each bee and their specific products. The Yolngu appreciate the bees' role in pollinating native plants (e.g., *Melaleuca* spp.) and their nest associations with particular plants [e.g., Stringybark trees (*Eucalyptus tetradonta*)]. The collection of honey and other products (wax, pollen and larvae) provides both dietary health and social benefits. Psychological benefits include improved social relationships through cooperation among people. Hunting and harvesting of the honey, bee products and larvae is considered favorite activity for Yolngu of all ages and of both sexes (Figure 5.18.). Apart from glucose, dietary benefits from the consumption of honey and larvae include carbohydrates, protein, fat, and essential minerals.

Both bees provide the Yolngu with strong connections that influence culture, social interactions and interaction with nature itself. Existing artefacts and paintings demonstrate a very long relationship between indigenous Australians and stingless bees. More specifically, historic evidence includes the presence of wax figurines from Arnhem Land (North-Eastern Northern Territory) (dated to be more than 4,000 years old) and rock wall paintings depicting bee hunting that has been dated from the Mesolithic period (Langley and Taçon, 2010).

people of Loagan Bunut, Sarawak (Malaysian Borneo), the Tanying tree *(Koompassia excels)* is revered for its spiritual values (Franco *et al.*, 2014) with a taboo on its felling, generating conservation of the tree, the bee nests in it and other animals that depend on it.

In Africa, traditionally-protected forests provide habitat for pollinators such as the fruit bat (*Rousettus aegyptiacus*) that pollinates the baobab (*Adansonia digitata*), which is widely used for food and medicine (Start, 1972). Examples include West Africa's sacred groves (Decher, 1997); and the *kayas* of the East African coastal region maintained by the Mijikenda peoples (Githitho, 2003). In southern Madagascar, local taboos provide strong and well-enforced protection for existing patches of forest (Tengö and Belfrage, 2004). Spatial modelling of crop pollination provided by wild and semi-domesticated bees (Apoidea) indicates that, in spite of the fragmented patches of forest across this largely cultivated landscape, these insects still contribute pollination throughout the entire landscape matrix; the taboo system also protect the bees and their pollination (Bodin *et al.*, 2006). In China, communities use indigenous knowledge and cultural traditions to support hunting taboos, and protection of sacred sites and forest habitats (Xu *et al.*, 2005).

5.2.7.2 Kinship relationships that protect pollinators and pollination resources

Kinship relationships also place responsibilities on people to care for animals with whom reciprocity means the well-being of both are inter-dependent (Rose, 1996; Sasaoka and Laumonier, 2012). Bees and people have totemic relationships in several Australian Indigenous societies (Hill *et al.*, 1999; Prideaux, 2006) **(Case example 5-5)**. The Lardil and Laierdila people's classification system based on totemism (which differs from their folk taxonomies) divides phenomena from the foundation of the clan totem into two patrimonies and four semi-moities. Interestingly, wind and a wind-pollinated tree are in the same semi-moiety, as are various fruits and pollinators (McKnight, 1999). Uitoto communities in Colombia pay special cultural respect towards scarab beetles, important pollinators, which are used for rituals and as medicine (Gasca, 2005). The Pankararé people from the arid zones of northeast region of Brazil classify bees or "abeias" according to the behavioral aspects as "abeias-brabas" (fierce bees) and "abeias-gentle" (gentle bees), and divide bees into three ethnofamilies

FIGURE **5-12**

Yolngu women collecting sugarbag in Arnhem Land, northern Australia. Still photos from the video "Sugarbag Dreaming". © Natasha Fijn. Reproduced from Fijn (2014) with permission.

A) A woman and two children in search of stingless bees, northeast Arnhem Land. Still from "Sugarbag Dreaming" video. © Natasha Fijn**.**

C) Scooping up liquid honey using a makeshift spoon made from a stick with a frayed end. Still from "Sugarbag Dreaming" video. © Natasha

B) The extraction of honey pots filled with bright yellow pollen from a Yirritja stingless bee nest, within a stringybark trunk. Still from "Sugarbag Dreaming" video. © Natasha

depending on the presence and/or absence of the sting. Bees and wasps are protected from human exploitation by guardian spirits of plants and animals called *encantados* (Costa-Neto, 1998).

5.2.7.3 Mental maps and animal behaviour knowledge as management practices

Knowledge in itself is a vital management practice for honey-hunters. For example, the Solega people of southern India have extensive mental maps of the location of individual trees and significant harvesting sites in the forest. Their knowledge of different migration and settling patterns of the various honey bee species of the region, and of their breeding schedules, is vital to their honey-hunting technologies (Si, 2013). Detailed knowledge of local people about behaviour of *Apis* spp. underpins diverse swarm capture, especially of wild swarms around the world (Marchenay, 1979). Indigenous people in Yuracaré, Cochabamba, Bolivia have detailed knowledge of the native birds that are pollinators of the forest, the trees that they pollinate, and their behaviour, which is vital to their customary forest usage (Castellón-Chávez and Rea, 2000). The Jenu-Keruba people, honey hunters in Kodagu southern India, identify 25 different micro-habitats in their forest and take advantage of four different bee species producing honey in habitats and seasons (Demps *et al.*, 2012a).

5.2.7.4 Fire management to enhance pollination resources

Vegetation fires in bear 'grass' (*Xerophyllum tenax,* in the Lilieaceae family), pollinated by pollen-eating flies (primarily members of the family Syrphidae), beetles (primarily *Cosmosalia* and *Epicauta* spp.), and small bees (Vance *et al.*, 2004), are managed by First Nations peoples in northern America to ensure production of this grass and promote qualities suitable for contemporary traditional purposes, such as basketry that requires strong, flexible, straight leaves (Charnley and Hummel, 2011). Traditional First Nation fire practices "favored beargrass, its habitat, its cultural uses, its flowers, and presumably, associated pollinator communities as well as other species that use it for food, habitat, and nesting material" (Charnley and Hummel, 2011). Experiments on abandoned farmland in south-eastern USA have found that fire promotes pollinator visitation indirectly through increasing the density of flowering plants, in that case the forb *Verbesina alternifolia*, suggesting the usefulness of fire management as a tool for supporting pollination (Van Nuland *et al.*, 2013).

5.2.7.5 Manipulation of pollination resources in different seasons and landscapes patches

Diverse management practices manipulate and access different resources in different parts of the landscape at different seasons. In the Petalangan community in Indonesia, pollination is enhanced through seasonal patterns of planting and harvesting, so that bees (*Apis dorsata* and *Apis florea*) can nest up to four times a year in the *sialang* trees, in accord with the flowering of different crops and during the slash and burn period that opens the forest to start planting (Titinbk, 2013). In the Kerio Valley of Kenya, papaya farmers maintain hedgerows for both practical, aesthetic and cultural reasons that conserve habitat and resources for hawkmoth pollinators of this dioecious pollinator-dependent crop (Martins and Johnson, 2009). Similar patterns can be observed in relation to cacao and biodiversity in Ghana (Rice and Greenberg, 2000; Frimpong *et al.*, 2011) and cowpea in Nigeria (Hordzi *et al.*, 2010).

Farmers in Roslagen (Sweden) protect bumble bees as important pollinators, including by restricting cutting of a tree species that flowers in early spring when other pollen- and nectar-producing plants are rare. In both locations, pollinator presence is further enhanced by the making of beehives and the management of field boundaries and mixed land that provides suitable insect habitat (Tengö and Belfrage, 2004). Producers of *maracuyá* (*Passiflora edulis*, passionfruit) in Colombia highly value pollinators, particularly black carpenter bees (*Xylocopa* spp.) which use dry trunks as their main habitat. Social bees (*Apis mellifera* and *Trigona* spp.) and hummingbirds are also important, and all three groups depend on proximity to forest. Farmers value the pollination from the forest highly (Calle *et al.*, 2010).

5.2.7.6 Biotemporal indicators for management actions

Seasonal "biotemporal" indicators, or "indigenous knowledge markers" trigger diverse management practices (Leonard *et al.*, 2013; Athayde, 2015). Flowering is the main indicator of times for honey harvests among Indonesian forest communities (Césard and Heri, 2015) **(Case example 5-6)**. Among the Kawaiwete (Kaiabi) people in the Brazilian Amazon, indicator species inform the start of the rainy and dry season. *Kupeirup*, a powerful female ancestral being, created crops and taught her sons how a flock of birds (a type of parrot) announces the right time to burn the fields (Silva and Athayde, 2002). The Boran people from Kenya deduce the direction and the distance to the honey nest from the greater honeyguide's *(Indicator indicator)* flight pattern, perching height and calls, and reward the bird with food that is more accessible after they have opened the nests (Isack and Reyer, 1989). Interactions with honey-guides have been

CASE EXAMPLE **5-6**

BIOTEMPORAL INDICATORS FOR HONEY HUNTING

Location: East Kalimantan, Indonesia

Punan indigenous peoples and local communities

In East Kalimantan, the Punan Kelay's (in Berau Regency) practices of bee-hunting are full of rituals that are stimulated by biotemporal indicators (Inoue and Lugan-Bilung, 1991). Natural signs trigger honey harvesting activities (Widagdo, 2011). If they hear certain calling of birds, they refrain from climbing the trees, because it is an indicator that the process will not be successful or may be dangerous. Before they start harvesting, traditionally they "call" the bees by the *keluwung* ceremony early in the honey season – usually around early October. The ritual involves erecting a tree branch and forming "nest like" figures from clay, followed by a ceremonial ritual expulsion of ghost/spirits from the tree, by throwing a partridge egg to the base of the tree. All these rituals are performed by chanting and praying, including a Christian element to traditional ceremonies (Widagdo, 2011).

Among the Punan Tubu (in Malinau Regency), the season for honey harvesting is signaled by the flowering of meranti (*Shorea* spp.), sago palm and several fruit trees, accompanied by singing of birds (e.g., great argus pheasant *Agursianus argus*) and cicadas, and followed by the breeding season for the wild pig (*Sus barbatus*). Hordes of boars migrate in anticipation of fruits. The mythology of the Punan Tubu tell of the link between bees on huge tree branches and pigs underneath since the creation time (Mamung and Abot, 2000).

found to increase the rate of finding honey by Hadza people in northern Tanzania by 560% (Wood *et al.*, 2014). The Ogiek people of Kenya use two types of birds for indicators when honey-hunting in the forest, and have migratory patterns that follow the production of different bees in the lowlands and the highlands (Samorai Lengoisa, 2015).

5.2.7.7 Providing pollinator nesting resources

Management practices for pollinators link landscape management with traditional housing in the Nile delta. Egyptian clover, part of mandated crop rotation, is pollinated by *Megachile* spp. (solitary bees) that nest in tunnels in the walls of mud houses. The bees depend on people to create a dynamic nesting habitat by constantly renewed mud walls, alfalfa and clover fields. However, populations of *Megachile* spp. in mud houses have been displaced or eliminated as modern brick and cement block buildings have replaced traditional mud houses (FAO, 2008). In Bolivia, one particular stingless social bee ("chakalari") is well known locally, in part because it makes its hives on the sides of the adobe houses (FAO, 2008). Other stingless bees like *T. angustula*, a species very appreciated for its honey, also use any cavity or container available in the houses to build their nests (Nates-Parra, 2005).

5.2.8 Diversified farming systems that influence agrobiodiversity, pollinators and pollination

Diversified farming systems of Indigenous peoples and local communities across the globe contribute to maintenance of pollinators and pollination resources, and represent an important multi-functional alternative and adjunct to industrial agriculture (Kremen *et al.*, 2012). These farms integrate the use of a mix of crops and/or animals in the production system. They employ a suite of farming practices that have been found to promote agro-biodiversity across scales (from within the farm to the surrounding landscape), and incorporate ILK systems, often involving hybrid forms of knowledge, negotiated between science, practice, technical, and traditions (Barber *et al.*, 2014). These farming practices in reality merge with the landscape management practices in the previous section. Here we consider some pollination-related aspects of several farming systems: swidden cultivation; home gardens; commodity agro-forestry; and farming bees.

5.2.8.1 Shifting cultivation

Swidden (shifting cultivation) systems, demonstrating diverse interdependencies with pollinators, remain important in tropical forest systems throughout the world, and are the dominant land-use in some regions (van Vliet *et al.*, 2012; Li *et al.*, 2014). For example, the traditional Mayan Milpa, multi-cropping swidden cultivation, produces a patchy landscape with forests in different stages of succession through spatial and temporal rotation, a dynamic system that produces a diverse array of plants, nearly all of which are pollinated by insects, birds and bats (Ford, 2008). Milpa has co-created some, and fostered much, of current forest plant diversity and composition during millennia of gardening the forest (Ford and Nigh, 2015). This system produces a territory of farms that combine agricultural, forestry and stockbreeding activities, organized around a domestic group, depending on local knowledge on the vegetation species and their uses, the domesticated animals and the crop systems (Estrada *et al.*, 2011) **(Case example 5-7)**.

CASE EXAMPLE **5-7**

MESOAMERICAN MILPA SYSTEMS, DIVERSITY AND FECUNDITY

Location: Guatemala and Mexico

Mayan-descendant people

The Popol Vuh, the Sacred Quiche Mayan book of Creation, begins with the clarification that "this book's face is hidden", directing the knowledge seeker to revelations in the way of living, the memories, culture, oral transmission, beliefs, spirituality and worldview of the people. In the Popol Vuh are stories of the hero twin gods, *Hunahpu* (Blowgun hunter) and *Xbalanque* (Young hidden/Jaguar Sun). The twins play a ballgame in the Underworld court and defeat the Gods with help of various animals and for their victory, their father, *Hun Hunahpu*, is resurrected in the form of maize (Raynaud, 1977).

The contemporary traditional Mayan Milpa systems keep these traditions alive today, an evolving and active response to changing contexts (Schmook *et al.*, 2013). The Milpa system also maintains in the surroundings diverse sources of food for people and resources for pollinators: macuy (*Solanum* sp.), bledos (*Amaranthus* sp.), Chaya (*Cnidoscolus chayamansa*), Tz'oloj-bell tree dahlia (*Dahlia imperialis*), Malanga (*Xanthosoma violaceum*), *Amaranthus caudatus*; and cultivated species like chayotes (*Sechium edule*), chile (*Capsicum* spp.), and black beans (*Phaseolus*), as wild relatives or in process of domestication, producing the high diversity of the system (Azurdia *et al.*, 2013; Janick, 2013).

A product largely related with fecundity is the honey from the Mayan Sacred Bee *Melipona beecheii* (*Xunan-kab*), associated with the concept of the Earth as a living entity composed of spirit, blood and flesh. Honey from *Xunan-kab* is considered "warm" and is seen as a living and essential fluid from the land where the bees are maintained and that men extract to obtain some of its vitality and fertility, but that eventually needs to be given back in the form of sacrifices (de Jong, 2001; González-Acereto *et al.*, 2008). Honey from *Xunan-kab* is used in special ceremonies to bless the Milpa for good crops (Quezada-Euán *et al.*, 2001).

CASE EXAMPLE **5-8**

HOME GARDENS, POLLINATOR DIVERSITY AND DOMESTICATION IN MESOAMERICA

Location: Guatemala and Mexico

Mayan-descendant people

Home Gardens have ancient roots in Mesoamerica. The practice originated around 6,000-200 BC probably as a way to keep food resources close and to attract animals for harvest – white tail deer, peccaries, squirrels and birds, including the great curasow, oscillated turkey, and quail. Since the Spanish invasion, Home Gardens have been integrating exotic domesticated species for many different purposes: medicine, food, ornament, diversity itself, raw materials for clothing, firewood and wood for construction (Janick, 2013). Home Gardens contain perennial habitat for pollinators (insects, birds and bats). Mesoamerican Home Gardens include at least 811 cultivated species, 426 plant species with multiple uses, 19 domesticated animal species and 25 semi-domesticated wild fauna. Mesoamerican Home Gardens are where the most ancient technologies for stingless beekeeping originated with the "Mayan honey bee" *Melipona beecheii*, kept in east-west oriented, especially built huts called *Nahil-kab*. Colonies are reared in horizontal hollow logs called *hobones* (Quezada-Euán *et al.*, 2001). In Mayan mythology, beekeepers are seen as guards and caregivers of *Melipona beecheii* rather than owners (de Jong, 2001). Other indigenous Mesoamerican groups like Nahuas and Totonacs practice stingless beekeeping along the highlands of the Mexican east coast, cultivating hundreds of colonies of *Scaptotrigona mexicana* (*Pisil-nek-mej*) in clay pots (Quezada-Euán *et al.*, 2001).

5.2.8.2 Home Gardens

Home Gardens, capitalised here to indicate those with food, support agro-biodiversity globally, in both developed and developing world contexts (Eyzaguirre and Linares, 2004; Gautam *et al.*, 2006; Bailey *et al.*, 2009; Reyes-García *et al.*, 2012). Home Gardens produce a variety of foods and agricultural products, including staple crops, vegetables, fruits and medicinal plants. They are characterized by structural complexity and multi-functionality, acting as social and cultural spaces where knowledge is transmitted, income and livelihoods improved, and pollinators find habitat (Agbogidi and Adolor, 2013). Home Gardens in Chinango, Mexico achieve almost double the fruit set of both wild and managed populations of the columnar cactus *Senocereus stellatus* (Arias-Coyotl *et al.*, 2006). Management practices in these gardens appear to reduce some negative pollination impacts associated with human cultivation; although flowers in the gardens received fewer total visits, they received significantly more visits from long-nosed bats (*Leptonycteris* spp.), and significantly more pollen grains on the stigmas (Arias-Coyotl *et al.*, 2006) **(Case example 5-8)**. Many traditional Home Gardens are forms of agroforestry; in tropical south-west China local people continue to collect, utilize and manage wild forest resources into these systems, thereby maintaining diverse genetically diversity, for example of the pollinator-dependent *Acacai pennata* (Gao *et al.*, 2012).

5.2.8.3 Commodity agroforestry

Agroforesty systems globally support commodity production, particularly of coffee, rubber, areca nut and cacao, with variable outcomes for pollination highly dependent on the intensity of management, for example of synchronicity of flowering (Boreux *et al.*, 2013; Robbins *et al.*, 2015). Two decades of ecological research into traditional shaded coffee plantations in Latin America show they provide refuges for biodiversity and a range of ecosystem services such as microclimatic regulation, and nitrogen sequestration into soil and pollination. One study identified the most predictive factors for bee abundance and species richness which were tree species, the number of tree species in flower, and the canopy cover of the coffee agroforestry (Jha and Dick, 2010; Jha and Vandermeer, 2010). An inverse relationship has been identified between farm size and agricultural productivity — in a number of countries smaller farms have higher crop yields than do larger ones (FAO, 2014c; Larson *et al.*, 2014). While these farms are more labour-intense than capital-intense, which limits their extent, especially in contexts of rural-urban migration, evidence is accumulating that in the tropical world the resulting landscape matrix with fragments of high-biodiversity native vegetation amidst the agriculture produces both high-quality food to the most needy and maintains ecosystem services such as pollination (Perfecto and Vandermeer, 2010; Nicholls and Altieri, 2013). Commodity agroforests with date palms have developed traditional direct hand pollination, including different techniques for date palms in several countries (Battesti, 2005; Boubekri, 2008; Tengberg *et al.*, 2013).

5.2.8.4 Farming of domesticated and semi-domesticated bees

The diversified farming systems of indigenous peoples and local communities include a range of practices for farming fully- and semi-domesticated bees. Family farmers in southern Brazil, settlers of the agrarian reform, *quilombola* (Afro-descendant peoples), and indigenous peoples of the region confirm that the presence of hives generates beneficial results for their crops, and noticeable improvements in the swarms that occur when the hives are installed next to abundant and diverse forests (Wolff, 2014). Traditional beekeepers in Morocco utilise the heterogeneity of their landscape, placing *taddart* (traditional hives) to adapt to climatic variations (long period of drought) and varying priorities, such as honey production, pollination of cultivated fields, swarm multiplication, and pollination of argan (*Argania spinosa*) trees (Simenel, 2011; Roué *et al.*, 2015). The beekeepers use knowledge about the specific influences of different plants on bee behaviour in their management (Crousilles, 2012). Many rural farming communities in sub-Saharan Africa include beekeeping as a means of sustainable development and for nutrition, managing wild plants, hedgerows, fallow areas and agro-forestry systems for improved pollinator and livestock nutrition. Some farming landscapes are known to have especially high bee diversity adjacent to forested areas (Kasina *et al.*, 2009; Gikungu *et al.*, 2011).

Meliponiculture (stingless bee keeping) is presently increasing throughout the tropical and sub-tropical world

CASE EXAMPLE **5-9**

FARMING AND SEMI-DOMESTICATING STINGLESS BEES BY TRIBES IN INDIA AND SOUTH AMERICA

Location: Tamil Nadu, India and Brazil

Kani Tribes (Kanikudiyiruppu, Mayilar and Periyamayilar) and Gorotire-Kayapo Indians

Tribal people of Western Ghats of India are rearing stingless bee (*Trigona* sp.) very successfully for pollination (Kumar *et al.*, 2012). The Kani tribes, in Kalakkad within Mundanthurai Tiger reserve (Tirunelveli district, Tamil Nadu) are using a very peculiar bee hive to rear these bees, which are normally wild. The honey produced by *Trigona irredipensis* is highly valued for treatment of many infections, and is a weaning food for infants. Trigona irredipensis are reared in hollow sections of bamboo that are tied below the roof of a hut and produce around 600-700g honey per year. Traditional knowledge about the honey's medicinal properties has recently been confirmed by a meta-analysis of three double-blind randomized clinical trials that found honey-coffee mixture outperforms the drug prednisolone in treatment of post-infection persistent cough (Raeessi *et al.*, 2014).

The Gorotire-Kayapo Indians have a semi-domesticated system of beekeeping for nine species of bees, including *Apis mellifera*. Brazil has a strong tradition in meliponiculture, especially in the northeast and northern regions (Cortopassi-Laurino *et al.*, 2006). The species *Melipona scutellaris*, *M. quadrifasciata*, *M. rufiventris*, *M. subnitida*, *M. compressipes*, *Tetragonisca angustula* and *Scaptotrigona* spp. are the most common species raised. Diverse indigenous names for these species have linguistic heritage values: *jataí, uruçu, tiúba, mombuca, irapuá, tataíra, jandaíra, guarupu,* and *mandurim* (Lenko and Papavero, 1996; Nogueira-Neto, 1997; Villas-Bôas, 2008).

and is supported by a range of practices and innovations for rearing stingless bees, farming their honey in unique hives, managing their pests and for stimulating their multiplication (Cortopassi-Laurino *et al.*, 2006) **(Case example 5-9)**. Local communities (indigenous peoples and settlers) in the "impenetrable chaqueño" (Argentina) are using meliponiculture as a tool for preserving this region through the application of modern techniques of reproduction and management of the stingless bees (Meriggi *et al.*, 2008).

5.2.9 Innovations in honey hunting, hives, beehandling and bee products

Traditional beekeeping and honey hunting practices have generated a wealth of innovations across the planet (Brown, 2001; Hausser and Mpuya, 2004). An array of diverse non-destructive stratagems are used by honey-hunters (Joshi and Gurung, 2005) **(Figure 5-13 A and B)**, diverse apiaries

FIGURE **5-13**

Innovations in honey hunting from around the world.

A) Colonies of giant honeybees (*Apis dorsata*) in Bahatpur village in Kulsi Reserve Forest in Kamrup district, India. © Ritu Raj Konwary. Reproduced with permission.

B) Honey hunter collecting from the nests of *Apis dorsata*. © Girish Chandra. Reproduced with permission.

C) Kurumba Indigenous people of the Nilgiris starting their yearly harvest, scaling precipitous cliffs and risking their lives to collect honey of the wild *Apis dorsata*. © Riverbank Studios. Reproduced with permission.

D) Honey hunter from the Gurung population of Nepal risk their lives to harvest *Apis dorsata laboriosa* on Himalayan cliffs. © Andrew Newey. Reproduced with permission.

E) Bakaya (forest-dwelling indigenous people) man in Cameroon climbing a tree to harvest honey. © Timothy Allen. Reproduced with permission.

and husbandry methods are used by human beekeepers, and a multitude of products have been derived from bees (Crane, 1999).

Honey hunters in Ethiopia manufacture a permanent system for scaling trees in order to make their task easier (Verdeaux, 2011). In India, honey hunters scale towering cliffs of the Nilgiri Hills of South India using ladders and social technology of songs at various stages of the operation (Anderson, 2001; Sunil Kumar and Reddy, 2011) **(Figure 5-13 C)**. In Nepal they use large bamboo ladders (Valli and Summers, 1988) **(Figure 5-13 D)**. Honey hunting in the tropical forests of Cameroon is a perilous activity involving climbing large tree trunks with a rope made of liana, carrying a small L-shaped axe to cut open the nest, a smoking tube for fumigating the aggressive bees, and a container to keep the precious liquid without losing a single drop (Ngima Mawoung, 2006). In central Africa, the indigenous peoples of the rainforest have developed many specific tools for honey collecting, including instruments to climb trees, and also gestures to communicate during honey hunting (Bahuchet, 1989) **(Figure 5-13 E)**.

In France and Spain, innovations in use include traditional swarming methods, extended beekeeping vocabulary, harvest and honey extraction techniques, and diverse smokers and smoking methods (Mestre and Roussel, 2005). Diverse traditional beekeeping techniques for construction of hives, the capture, promotion and delay of swarms have been reported across Asia **(Case example 5-10)** and west

CASE EXAMPLE **5-10**

TECHNOLOGICAL INNOVATIONS FOR HIVES AND HONEY HARVESTS IN ASIA

Location: India, Laos, Kalimantan

Several local communities across these locations

Several traditional honey harvesting methods with various materials and types are used by some local people in India. Kinnaur people used bamboo to make log hives (Beszterda, 2000). Chamoli people used wall hives made from cow dung or clay, log hives from bamboo and rectangular wooden box hives with various sizes in different localities (Tiwari *et al.*, 2013). Kani tribes used bamboo hives for stingless bees (Kumar *et al.*, 2012).

Local people in Laos, particularly in Northwestern region of Laos (Meung district of Bokeo Province) use rustic log hives for their traditional beekeeping practices (Chantawannakul *et al.*, 2011). In Indonesia, the basic structure for beekeeping involves putting two poles into the ground, or using two tree branches, and adding a third pole or sheet of wood on top. In Western Kalimantan the structure is called *tikung* (Figure 5.21.), in Sulawesi it is called *tingku*, and in the Belitung it is known as *sunggau*. Several communities have also developed "nesting sites" to attract feral colonies of *Apis dorsata* (Hadisoesilo and Kuntadi, 2007).

In Belitung, people link gelam flowers (*Melaleuca leucadendron*) to attracting large swarms from the nearby islands of Sumatra and Borneo. Honey bees are seen to first arrive for the pollen, then proceed to build wax comb and wait on the rafter until the flowers produce nectar (Césard and Heri, 2015).

FIGURE **5-14**

Traditional Ethiopian bee hives in trees. © Peter Kwapong. Reproduced with permission.

The hives are simple six-foot cylinders made of cane and lined with leaves. They are placed empty in the forest tree tops with the leaves of the Limich plant *(Clausenia anisate)* used to attract swarms of honey bees.

Africa (Villières, 1987), east and north Africa (Hussein, 2001; Roué *et al.*, 2015) **(Figure 5-14)**, and in Chad (Gadbin, 1976). In the southern part of Algeria, the local people's tradition is to implement isolated hives in open areas, or organize houses and villages specially built for bees ("houses-apiary" located in "villages-apiary") (Rivière and Faublée, 1943; Hussein, 2001).

In Indonesia, traditional beekeepers use a rafter system, where a piece of wood is paced in a tree to attract nesting bees **(Case example 5-10, Figure 5-15)**. Enduring traditional beekeeping in the Cévennes (a mountain range in the South of France) uses a specific type of hive, dug in a portion of a tree trunk, that is called *ruchers-troncs* (Lehébel-Perron, 2009). Chestnut tree hives repel wood parasites and remain in production for several hundred years without any chemical treatment (Chevet, 2010; Pierlovisi, 2015). Pastoral beekeeping, also called transhumance of bees, has existed for a long time in the landscapes of Europe. Traditional pastoral beekeepers transport their hives directly to orchards during flowering periods, delivering mutual benefit for beekeepers and farmers, resulting in many different types of honey (Mestre and Roussel, 2005).

In Nepal and India, innovations extend to pest management practices such as use of cow dung (effective against wax moth, wasp, lizard) and polythene sheets to protect against lizards and tree frogs (Singh, 2014) **(Case example 5-11)**. In south Morocco, beekeepers manage *Varroa* sp. mite by smoking hives with certain plants that inhibit the action of the mite, and by placing their hives near plants from which bees harvest latex that is transformed into propolis

FIGURE **5-15**

A honey plank (tikung) used in traditional beekeeping in the Danau Sentarum National Park, West Kalimantan province, Indonesia. Source: Hadisoesilo and Kuntadi (2007). Photo © N. Césard. Reproduced with permission.

CASE EXAMPLE **5-11**

INNOVATIONS FOR SWARM CAPTURE, BEE HANDLING AND DISEASE MANAGEMENT IN NEPAL

Location: Jumla, Western Nepal (Saville and Upadhaya, 1998)
Jumla indigenous people

Apis cerana, the Asian bee, is threatened throughout Asia. The *Apis cerana* variety found in Nepal is high yielding compared to other Himalayan strains. Hollowed out logs are used to made cylindrical and square cross section hives in Jumla. The timber logs, i.e., *Ilex dipyrena* (kharso), *Juglans regia* (okher) and *Pinus wallichii* (sallo) are used for bee hives. About 85% of farmers used different baits to attract and capture the swarm. Mostly beekeepers used baited hives, rubbing their hives with 'gosard' (a hive baiting substance), and few of them used raw honey only. Some farmers scorch the inside of the hive and scrub it with fresh walnut leaves. Other materials are also used: cow ghee (clarified butter); wild rose flowers (*Rosa moschata*); dhoopi (*Juniperus* spp.); (roasted) de-husked rice; (roasted) barley; or mustard oil and cloves.

For handling bees, a local *Artemisia* species known as *gwiepattior titepatti* (*Artemisia vulgaris*) is placed near the bee hive and rubbed to give off a strong scent. A *kangreto*, made out of old cotton cloth, is tied into a roll and used as smoker. Some people used specific herbs to produce a good smoke that encourages bees to leave the combs without inducing too much disturbance.

Jumla farmers recognize diseased bees in various ways: angry bees, absconding, inactive bees, or bees hanging together by the feet. Brood disease is recognized when bees are seen throwing out dead larvae, or by sour smell and black combs. Buckwheat is valued for its bitter properties and applied around the exit hole of bee hives during the spring. Bees encounter it on their way out for the first foraging trips of the year as a medicine against disease that affects bees at this time. In Jumla, some farmers use *Juniperus* spp. smoke for disease treatment (Saville and Upadhaya, 1998).

with mite-inhibiting effects (Roué *et al.*, 2015). In Brazil, technologies and innovations of traditional practices of stingless beekeeping have been brought together into several manuals (Nogueira-Neto, 1997; Venturieri, 2008; Witter and Nunes-Silva, 2014).

Many innovations have developed from use of bee wax in east Africa. Wax is seen as a negotiable residue or can serve to repair objects, to soften skins, and to make crafts or jewellery (Gadbin, 1976; Villières, 1987). In Australia, cerumen (wax made by bees from plant materials and their excretions) has been found in protective covers, fashioned around ancient rock paintings, to protect them from rain and erosion, and to create shapes of humans, dingoes, turtles, and spirit figures on the rock surface (Halcroft *et al.*, 2013). Cerumen is still used by Australian Aboriginal artists and craftsmen to manufacture items for use and sale including hunting tools such as spears ("kek") and woomeras ("thul"), as well as firesticks "(thum pup") and mouth pieces for didgeridoos, a traditional musical instrument (Yunkaporta, 2009; Koenig *et al.*, 2011).

5.2.10 Adaptation to change

Beekeeping has been demonstrated to be closely linked with traditional knowledge and adaptation to climate change in Ethiopia (Bogale, 2009; Kumsa and Gorfu, 2014), and it is connected to self-reliance in Southern Africa (Illgner *et al.*, 1998; Nel *et al.*, 2000). Seven mechanisms of environmental adaptation have been identified among the Xingu Kawaiwete (Kaibai) of Brazil: 1) knowledge innovation in development of nomenclature for ecological zones and new species of bees; 2) increase in diversity of resources used for different purposes (e.g., to build canoes) due to village sedentarization and scarcity of important forest resources; 3) agrobiodiversity conservation and recuperation of crop diversity, including through cultivating pollinator resources; 4) travel to ancestral land to collect resources; 5) substitution with other local species; 6) exchange of varieties and seeds among families, villages and other ethnic groups; 7) semi-domestication (e.g., of invasive bees) or intentional management – through experiments for planting and protecting key resources (Athayde *et al.*, 2006; Athayde, 2010; Athayde, 2015) **(Case example 5-12)**.

5.3 POLLINATORS, POLLINATION AND GOOD QUALITY OF LIFE

5.3.1 Good quality of life and categories of values

Pollinators support numerous categories of value that contribute to good quality of life **(Table 5-2)**. Here we consider three categories of relational values through a socio-cultural valuation lens — heritage, aesthetics and identity — and a further three categories through a holistic valuation lens — livelihoods, social relations and governance.

5.3.2 Heritage values, pollinators and pollination (socio-cultural valuation)

Heritage can be understood as *tangible* physical objects and places that are passed between generations, and *intangible* aspects such as language or practices. Historical features, practices and places are considered heritage

CASE EXAMPLE **5-12**

INNOVATIONS TO FOSTER POLLINATORS AND POLLINATION BASED ON TRADITIONAL TECHNIQUES

Location: Central America and Colombia

Indigenous women; Florina López Miro, oral presentation, p. 39 (López *et al.*, 2015)

Co-produced case example
Underpinned by direct interactions with indigenous and local knowledge-holders

"In many cases insects like bees and butterflies that we used to see in great quantities in our communities are not there anymore. Regarding food production, we have lost our people's tradition seeds and propagules because the work of the pollinators has been affected. Our knowledge has been eroded by the impact of climate change in our communities, related to the loss of traditional seeds and propagules."

"Many women in different places traditionally manage and control the seeds and propagules, but this is decreasing. Now women are working to recover IK and use seeds (which require pollination) as well as propagules, for example, in the processing of yuca (*Manihot esculenta*). In Colombia, a group of Witoto (Huitoto) women working to recuperate traditional seeds are running a restaurant that sells traditional cuisine … they've developed a fruit ice cream [that provides income]. In other words, they are developing projects to support biocultural diversity, [including seeds requiring pollination, not just vegetative propagation]. In Guatemala, Mayan women are working on orchid production, encouraging pollination. In El Salvador, they are working with petals of the veranera flower to produce a medicinal syrup. We are also working with young people. In sum, we are innovating with IK, looking for ways to improve traditional techniques …Pollination is very important."

because we ascribe value to them (Muňoz Viňas, 2005). The *Convention for the Safeguarding of the Intangible Cultural Heritage*[5] and the *Convention Concerning the Protection of the World Cultural and Natural Heritage*[6] are international agreements to recognize and protect intangible and tangible heritage, and several have been listed where the heritage values depend on peoples' interactions with pollinators and pollination webs. The Globally Important Agricultural Heritage Systems[7] (GIAHS), an initiative of the Food and Agricultural Organization (FAO) of the United Nations, supported by a number of partners, has five criteria for selection, one of which (biodiversity and ecosystem function) specifically recognizes pollinators and pollination services.

The GIAHS initiative aims to safeguard and protect the world's agricultural systems and landscapes that have been created, shaped and maintained by generations of farmers and herders based on diverse natural resources, using locally-adapted management practices (Koohafkan and Altieri, 2011). There are now 32 designated GIAHS sites globally, and a further 95 potential sites, of an estimated 200 diverse systems around the world (FAO, 2015). The designated Pu'er Traditional Tea Agrosystem of China recognises the agro-biocultural diversity of (pollinator-dependent) wild tea tree populations, together with tea plantations that rely on traditional multi-layered forest cultivation methods of the Blang, Dai, Hani and other minorities, and their local institutions that protect the ancient plantations[8,9]. The designated Lemon Gardens of Southern Italy recognises the unique pergola-growing that produces distinctively flavoured high-value (pollinator-assisted) lemons grown in small farms that rely on traditional intensive labour systems[10].

The Representative List of Intangible Cultural Heritage has recognised the "Argan practices and know-how concerning the argan tree (*Argania spinosa*)" from Morocco as globally significant. This cultural heritage relies on insect-pollination success to produce a fruit with diverse forms that is harvested, dried, pulped, ground, sorted, milled and mixed to derive an oil used in cooking, medicines and cosmetics, relying on traditional knowledge of recipes and tools (Bani-Aameur and Ferradous, 2001). Other listed Intangible Cultural Heritage that rely on successful pollination of particular fruits include Kimjang, making and sharing kimchi

5. http://www.unesco.org/culture/ich/en/convention
6. http://whc.unesco.org/en/conventiontext/
7. http://www.fao.org/giahs/giahs-home/tr/
8. http://www.fao.org/giahs/giahs-sites/asia-and-the-pacific/puer-traditional-tea-agrosystem-china/en/
9. http://whc.unesco.org/en/tentativelists/5810/
10. http://www.fao.org/giahs/giahs-sites/europe/lemon-gardens-southern-italy/detailed-information/en/

FIGURE **5-16**

Colombian coffee landscape in the Risaralda Department. © Catalina Gutiérrez Chacón, Reproduced with permission.

in the Republic of Korea (chillies)[11]; and Washoku, traditional dietary cultures of the Japanese, notably for the celebration of New Year, relying on pollination of a diversity of crops (vegetables and edible wild plants)[12].

Several Cultural Landscapes on the World Heritage List rely on pollinators and pollination and their interactions with humanity. In the *Coffee Cultural Landscape of Colombia*[13], coffee production is linked to their traditional landownership and the distinctive small farm production system (Winter, 2015). The Landscape forms a corridor that connects different forest fragments, with diverse herbaceous and shrubby plants providing habitat with food sources, nesting sites and protection for resident and migratory animals, including 230 species of birds and 50 species of bees (Botero *et al.*, 1999; Jaramillo, 2012) **(Figure 5-16)**. The stingless bees *Paratrigona eutaeniata* and *P. lophocoryphe* build their nests on the branches of the coffee trees, and are known as “angelitas del café” (little angels of coffee). Native bee communities within shade coffee farms ensure against the loss of introduced honey bees (Winfree *et al.*, 2007), increase coffee yields (Klein *et al.*, 2003) and maintain the reproduction and genetic diversity of native trees (Jha and Dick, 2010; Nates-Parra and Rosso-Londoño, 2013).

FIGURE **5-17**

Bats (*Leptonycteris* sp.) pollinating Agave sp. flowers. © Rodrigo Medellín. Reproduced with permission.

Other pollinator-dependent World Heritage sites include the *Classical Gardens of Suzhou*[14] which celebrates the Chinese traditions of gardens that mimic natural processes with many flowering plants. The dense forest of the *Osun Sacred Grove*[15] on the outskirts of the city of Osogbo, is protected by Yoruba peoples as the abode of the goddess of fertility Osun, without whose involvement plants do not bear fruit and rains do not fall (Probst, 2011; Onyekwelu and Olusola, 2014). The *Agave Landscape and Ancient Industrial Facilities of Tequila*[16] in Mexico recognizes the biocultural diversity of the plant used since at least the 16th century to produce tequila spirit and for at least 2,000 years to make other fermented drinks, fibre and cloth. Tequila production today relies on clones from offshoots of mother plants, which is believed to be facilitating rapid spread of diseases due to the crop’s low genetic variability (Torres-Moran *et al.*, 2013). Efforts at controlling the disease organisms and vectors have achieved limited success, and attention is now focusing on traditional management practices that produce *Agave* spp. landraces with high genetic diversity, relying on bats for pollination (Dalton, 2005; Zizumbo-Villarreal *et al.*, 2013; Tlapal Bolaños *et al.*, 2014) **(Figure 5-17)**. Indigenous farmers have selected plants with desired traits from diverse individuals, producing at least twenty different land-race, and continue to use wild agave supporting ongoing diversification (Arita and Wilson, 1987; Colunga-GarciaMarin and Zizumbo-Villarreal, 2007; Zizumbo-Villarreal *et al.*, 2013; Trejo-Salazar *et al.*, 2015).

5.3.3 Identity values and pollinators (socio-cultural valuation)

Pollinators feature as symbols that identify nation-states, indigenous nations, tribes and other communities throughout the world (Kristsy and Cherry, 2000; Werness, 2006; Dell, 2012).

The New Year festival of the Jewish religion, Rosh Hashanah, celebrates the creation of humanity in the Garden of Eden and is marked by eating honey cake, or apples dipped in honey which symbolizes the aspiration for a sweet future year (Goodman, 1970). Honey bees are the state insect of Utah, and are of profound importance to the Mormon culture, symbolising the industry, harmony, order and frugality of the people and the sweet results (Dickason, 1992) **(Figure 5-18)**.

The hummingbird *(Trichilus polytmus)* is the national symbol of the island Jamaica (Bigley and Permenter, 2009) **(Figure 5-19 A)**. Many different indigenous tribes in the United States of America (USA) use hummingbirds in myths or legends (Bastian and Mitchell, 2004). For example, Hopi

14. http://whc.unesco.org/en/list/813

15 http://whc.unesco.org/en/list/1118

16 http://whc.unesco.org/en/list/1209

and Mojave Creation myths say that a hummingbird guided the people from their underground kingdom to light and taught them to make fire (Courlander, 1971; Mullett, 1979; Leeming and Page, 2000). Taino Indians, the indigenous people of Puerto Rico (Borikén) believe hummingbird is a noble warrior, teacher and sacred pollinator who brings new life (Jatibonicu Taino Tribal Nation of Borikén, 2015).

The crimson sunbird *(Aethopyga siparaja)* is the national bird of Singapore (Minahan, 2010). The National Flower of Mauritius is *Trochetia boutoniana*, a rare endemic that produces a coloured nectar that attracts its lizard pollinator, the Mauritius Ornate Gecko *Phelsuma ornata* (Hansen *et al.*, 2006) **(Figure 5-19 B)**.

FIGURE **5-18**

Bees hive symbol on road signs and in front of Utah State Capitol building, United States of America. © Gretchen LeBuhn. Reproduced with permission.

The beehive is a symbol of industry, perseverance, thrift, stability, and self-reliance.

FIGURE **5-19**

Hummingbird (*Trichilus polytmus*), the National Symbol of Jamaica and the National Flower of Mauritius (*Trochetia boutoniana*) with is pollinator Mauritius Ornate Gecko *Phelsuma ornata*.

A) Stamps celebrating the national symbol of Jamaica. © Unknown.

B) Phelsuma cepediana nectar-feeding at Trochetia blackburniana, the National Flower of Mauritius. Picture on the right shows the gecko preferentially feeding on the coloured nectar supplied by this unusual flower. Source: Hansen *et al.* (2006). Reproduced with permission.

Butterflies are also commonly used as symbols of nations and states, and in festivals across the globe (Howse, 2010). The endemic birdwing butterfly *Troides darsius* is recognised as the national butterfly of Sri Lanka (van der Poorten *et al.*, 2012). Twenty-three states in the United States of America have butterflies as their state insects, commonly the monarch, which is also used in corporate symbols. In Africa, the Bwa of Burkina Faso dance at agricultural festivals wearing huge butterfly masks, up to seven feet across, with circles and designs representing the markings on the wings, to symbolise fertility and new life brought by the first rains (Wheelock and Roy, 2007) **(Figure 5-20)**. Celtic culture in Europe uses butterflies as symbols of rebirth and transformation in contemporary culture shamanistic practices and Celtic designs in diverse crafts, including body tattoos (Pearce, 1996; Conway, 2001).

Bumble bees have symbolic significance among many north and central American peoples: the Chiricauhua Apaches have a myth that bumble bees preserve fire in their home in a yucca stalk; Shasta people tell of bumble bees surviving the flood (Farrand and Frachtenberg, 1915; Olper, 1942). The Nadaco (or Anadarko) tribe from eastern Texas are named Nadá-kuh meaning “bumble bee place” (Fogelson and Sturtevant, 2004) and the Hohokam had a ‘Bumblebee Village’ (Ferg *et al.*, 1984). For Thalhuicas (Pjiekakjoo) people in Mexico, bumble bees themselves symbolise the ancestors’ souls that appear around the day of the death to visit their families (Aldasoro, 2012).

5.3.4 Aesthetic values and pollinators (socio-cultural valuation)

Pollinators are valued indirectly via their link to insect-pollinated plants, particularly those with showy flowers such as orchids, roses, sunflowers and many others that are aesthetically important as components of landscapes, vistas, gardens or parks (Hochtl *et al.*, 2007; Schmitt and Rakosy, 2007; Wratten *et al.*, 2012) **(Figure 5-21)**. Traditional European agricultural landscapes with flowering plants are also highly regarded for their cultural values (Reif *et al.*, 2005; Rusdea *et al.*, 2005). In Switzerland, studies have shown that people favour improving and creating field margins as habitat for species, landscape diversity and aesthetic value, and also showed marked preference for the season when plants are flowering (Junge *et al.*, 2009, 2015).

Traditional European beekeeping apiaries and their protective structures also add aesthetic value to the landscapes. Apiaries are built in specific areas in order to protect bees from cold, heat, wind and predators. In Slovenia, little wooden houses that protects bees are painted with pictures, so that bees can find them more easily, and to help the beekeeper distinguish hives and remember which colonies had already swarmed. The picturesque images depicting historical events, Bible stories, and everyday village life, enrich the cultural Slovenian heritage, transforming the landscape into an outdoor art gallery (Rivals 1980, Beattie, 2006). The Museum of Ancient Beekeeping in Lithuania, in the Aukštaitija National Park, celebrates the God of bees Babilas and the goddess Austėja from Lithuanian mythology and is surrounded by wooden sculptures representing the mythology of the origin of the bee in different cultures: Egyptians, American Indians and Lithuanians (Association of Lithuanian Museums, 2014). In Southern Europe, especially in France and Spain, it is common to meet specific apiaries, called *mur à abeilles* (bee-walls) directly constructed in a rock wall or protected by an enclosure in the landscape. Similar beekeeping apiaries are found in other European countries, especially those where rock is frequently used for human constructions (Mestre and Roussel, 2005).

FIGURE **5-20**

Bwa butterfly plank mask. Wood, paint and rafia. © Christopher D. Roy. Reproduced with permission.

The butterfly (horizontal) mask is danced in a festival, and symbolises the life-giving power of nature.

FIGURE **5-21**

Gardens for pollinators

A) *Bombus* spp. in Oxford Gardens. © Berta Martin-López. Reproduced with permission.

B) *Bombus* spp. in gardens of the Colombian Andes (La Calera, Cundinamarca). © Guiomar Nates. Reproduced with permission.

C) The BEE-UTIFUL Gardens at Lake Merritt, California.

5.3.5 Livelihoods of indigenous peoples and local communities – income, foods and medicines (holistic valuation)

Pollinators, primarily bees, provide a source of income, food and medicines that are vital to the livelihoods of many indigenous peoples and local communities globally (Gupta *et al.*, 2014). Beekeeping provides a critical anchor for many rural livelihoods: minimal investment is required; diverse products can be sold; land ownership or rental is usually not necessary; family nutrition and medicinal benefits derive; timing and location of activities are flexible; and links to ILK and traditions are usually numerous (Hilmi *et al.*, 2011). Recovery of stingless beekeeping with diverse hives and techniques is currently underway across central and South America **(Case example 5-13, Figure 5-22)**.

Traditional honey-hunters in India organise to send their honey to a local tribe cooperative where it is sold for medicinal properties, as well as using it themselves. Prayers and rituals accompany these harvests, linking the customary and market economies (Barlagne *et al.*, 2009). Ethiopian farmers have developed beekeeping as a good source of income, through multiplication and selling of honey bee colonies in the local market as domesticated animals (Adgaba, 2000). Local people in Kechifo, Ethiopia both trade white honey for both cultural and economic purposes (Avril, 2008). Many communities in Africa keep bees for the direct economic benefit of selling honey and other honey bee-derived products (Adjare, 1990), and also appreciate and value bees as a long-term means towards to improve household food and nutritional security (Villières, 1987; Fischer, 1993; Sanginga, 2009).

Beekeeping has improved rural household nutrition in many subsistence farming communities across Africa (Wilson, 2006; Martins, 2014) and is used to make honey beer (Adgaba *et al.*, 2008). In Nigeria in both rural and peri-urban settings household nutrition is improved through beekeeping (Azeez *et al.*, 2012). Collection and harvesting of honey occurs across sub-Saharan Africa by: the Abayanda of Uganda (Byarugaba, 2004); Batwa and other pygmy peoples in the Congo Basin forests (Crane, 1999; Kajobe, 2007; Kajobe, 2008); the Hadza in Tanzania (Marlowe *et al.*, 2014); the Ogiek in Kenya (Rambaldi *et al.*, 2007); and by nomadic pastoralists in Somalia and other regions of the Horn of Africa (Tremblay and Halane, 1993). In Australian Aboriginal societies, stingless bee honey (sugar-bag) is a popular food (Fijn, 2014).

Honey is also used as food for several tribes and local communities in Indonesia, such as Anak dalam tribe

CASE EXAMPLE **5-13**

RECOVERY OF STINGLESS BEEKEEPING FOR SUSTAINABLE LIVELIHOODS IN LATIN AMERICA

Location: Mexico, Colombia, Brazil

Diverse indigenous peoples and local communities across Latin America

Stingless beekeeping probably represents one of the best examples of a sustainable practice that is slowly recovering from a reduction in some areas of Mesoamerica to a thriving activity nowadays, practiced by various indigenous groups in Central Mexico, Colombia and Brazil.

Across the Americas, detailed identification systems of stingless bee species, their biology and behaviour is part of the knowledge of the Maya and Nahuas groups in Mexico and Guatemala, in the Brazilian Amazonia (by the Gorotire-Kayapo, Ticuna, Cocama and Mura) and the Midwestern, Southeastern and Northeastern Brazilian regions (Guarani M'Byá, Kawaiwete, Enawene-Nawe and Pankaraé), in Ecuador (Cayapa) and the Colombian tropics (Andoque, Eastern Tukano (Siriano and Bará) and Nukak) and temperate regions (the U´wa) (Posey 1983b, a; Camargo and Posey, 1990; Costa-Neto, 1998; Cabrera and Nates-Parra, 1999; Quezada-Euán *et al.*, 2001; Rodrigues, 2005; Ballester, 2006; González-Acereto *et al.*, 2006; González-Acereto *et al.*, 2008; Santos and Antonini, 2008; Rosso-Londoño, 2013).

Recently partnership efforts led mainly by academics and universities have been reviving and strengthening stingless beekeeping, bringing science and tradition together. Several modern techniques and innovations have been developed to maintain and reproduce colonies efficiently, to improve the quality and marketability of products and also by starting to use colonies for services such as commercial pollination. Stingless beekeeping is showing signs of recovery for various indigenous groups of Argentina, Bolivia, Brazil, Colombia, Ecuador, Mexico, and Venezuela and people outside these communities are also getting involved in stingless beekeeping and commercialization of products.

Key elements for the recovery of stingless beekeeping have been: teaching and extension work, respect for their local costumes and traditions, increased value of products, and development of a market niche for stingless bee products. Key elements for the recovery of stingless beekeeping in the Yucatan and Brazil have been: teaching and extension work, respect for their local costumes and traditions, increased value of products, and development of a market niche for stingless bee products (González-Acereto *et al.*, 2006; Jaffe *et al.*, 2015).

FIGURE **5-22**

Stingless beekeeping in Central and South America.

A) Jobones (Meliponaries, stingless beehives), in Mexico.
© Javier Quezada-Euán reproduced with permission.

B) Mayan family with jobones in Mexico.
© Javier Quezada-Euán Reproduced with permission.

C) Meliponarie Nahua (*Scaptotrigona mexicana*) in earthenware pots, Sierra Norte de Puebla, Mexico
© Javier Quezada-Euán Reproduced with permission.

D) *Melipona favosa* nests in earthenware pots in Guanare, Venezuela. © Guiomar Nates Parra. Reproduced with permission.

E) Different kinds of nests for stingless bees in Colombia.
© Guiomar Nates Parra. Reproduced with permission.

F) Stingless beekeeping in Northeast of Brazil.
© Juan Manuel Rosso.
Reproduced with permission.

(Ibrahim *et al.*, 2013), Sakai tribe (Suparlan, 1995), Petalangan people (Titinbk, 2013) and Kelay Punan tribe (Widagdo, 2011). Crane (1999) recorded that native people in other Southeast Asian countries such as Vietnam (Annam people), Cambodia, Malaysia, Thailand (Lao people), Myanmar (Burmese people) also used bee products as food. In Thailand, people believe that consuming honey and brood will have a good impact on their health (Chantawannakul *et al.*, 2011). Flying foxes are recognised as a vital pollinator and also a delicate and very popular dish in Vanuatu and Fiji (Palmeirim *et al.*, 2007).

For indigenous communities from South America (Andoque, Guaycurúes, U'wa, Yuquí, Toba-pilagá, Tukano), stingless bees are part of their cosmogony and mythology and important as nourishment and to obtain products used in the elaboration of alcoholic beverages, instruments and handicrafts (Ruddle, 1973; Jara, 1996; Cabrera and Nates-Parra, 1999; Falchetti and Nates-Parra, 2002; Arenas, 2003; Falchetti, 2003; Stearman *et al.*, 2008; Medrano and Rosso, 2010; Zamudio *et al.*, 2010; Zamudio and Hilgert, 2011; Estrada, 2012; Zamudio and Hilgert, 2012; Nates-Parra and Rosso-Londoño, 2013; Rosso-Londoño, 2013). Stingless bees' honey is greatly valued for its medicinal properties, e.g., antibiotic and antibacterial properties, especially with *Tetragonisca angustula* honey (called angelitas, rubitas, señoritas) in Andean countries (Posey, 1983b, a; Estrada, 2012; Fuenmayor *et al.*, 2013; Rosso-Londoño, 2013; Vit *et al.*, 2013; Zamora *et al.*, 2013) and *Melipona beecheii, Trigona nigra, Cephalotrigona zexmeniae, Frieseomelitta nigra, Scaptotrigona hellwegeri, Melipona fasciata* and *Geotrigona acapulconis* in Mexico and Central America (Quezada-Euán, 2005; Ocampo-Rosales, 2013; Reyes-González *et al.*, 2014). In the Misiones province (Argentina) research has focuses on the usage of stingless bee products and plants of the region in traditional medicine, giving also relevance to different names given to bees by the local communities (Zamudio and Hilgert, 2011; Zamudio and Hilgert, 2012).

Honey has been used for medicinal purpose by many societies, such as the Mayan, for millennia (Ocampo-Rosales, 2013). In Polish traditional medicine, for example, honey has been a popular remedy to treat respiratory diseases, gastrointestinal disorders, dermatological problems, heart disorders and for contagious diseases (chickenpox, measles). Different mixtures suit different purposes—to treat cold and flu, honey, butter and garlic are added to hot milk or vodka; to treat contagious diseases, like measles, lacto-fermented cabbage juice is mixed with whey, honey and fat. Local communities in Argentina of Polish and multiethnic populations now distinguish honey from seven different *Hymenopteran* ethnospecies to treat respiratory, dermic, osteo-artomuscular, nervous, digestive and circulatory disorders (Zamudio *et al.*, 2010). Honey has been found to be more important as a medicine than a food for local peoples in Brazil and Mexico (Ramos-Elorduy *et al.*, 2009). In Ethiopia, wild honey is usually consumed without filtration, still including wax, pollen, and royal jelly, constituents that strengthen its nutritional properties (Avril, 2008). The Pankararé from Brazil uses honey, pollen and wax as medicine, and use specific honey from different species of stingless bees to treat specific diseases; 11 species provide 13 raw materials used to prepare remedies to treat or prevent 16 illnesses (Costa-Neto, 1998).

Honey is very widely used in traditional medicine in Africa. It can be used alone or in combination with medicinal

CASE EXAMPLE **5-14**

HONEY BEER AND HONEY WINE

Location: Zambia and Ethiopia

Honey beer is important for multiple reasons in Zambia. It is taken during the initiation ceremonies when boys and girls reach mature age, during traditional chiefs' ceremonies and as payment for cultivating or harvesting fields. After a day's hard work, some people go to bed early and start drinking honey beer at 3am and by 6am are ready for hard manual work. Local communities warn the smell of the honey beer on people irritates the bees to attack, so you cannot work with bees. Honey beer cannot be stored for more than 48 hours.

In Ethiopia, honey is made into Tej, honey wine. Tej is a very important drink in Ethiopian cultural life, served at traditional gatherings and special religious ceremonies. Tej is often it is drunk before the brew has started to ferment, when it still has a strong yeasty flavor. This drink is called birz and is popular with children and, being non-alcoholic, is acceptable to Muslims. Tej is made in huge wooden barrels, which are cleaned and then scoured with special leaves. The barrel is then filled, one part of honey with five parts of water and covered with a clean cloth and left for a few days to ferment. Gesho, leaves of *Rhamnus prinoides*, which have been chopped up and then boiled are added, stimulating sugars to convert to alcohol and the Tej increasingly acquires its distinctive dry and bitter flavor. Finally, just before serving, a further half bucket of honey is tipped in to give sweetness to the final brew.

Tej is served in special glasses called birrille, held in a special and rather dainty way between the first two fingers and thumb. In Africa it is usually women who brew beer, make Tej, and sell these products.

plants to treat numerous pathologies, especially those concerning respiratory tracts or dermatologic problems, fever and traumas. Honey has been widely used in Africa to help with the healing of wounds (Armon, 1980) and other ailments (Manyi-Loh *et al.*, 2011), with recognition of its anti-microbial properties being linked to the plants that the honey bees foraged on (Basson and Grobler, 2008). This is a value appreciated by many communities in the Greater Horn of Africa region, where bitter honeys that result when honey bees forage on certain plants, including succulent euphorbias and *Commiphora* spp. in drylands, are especially useful for treating infected wounds and other skin problems (El-Kamali, 2000). This usage of honey for treating wounds is also widely employed among pastoralists in this region for treating their livestock (Gakuya *et al.*, 2010). In some local communities, for instance from South of Morocco, each kind of honey has special therapeutic indications (Crousilles, 2012; Simenel, 2015). Local people in Maningri, Benin report many medicinal uses of honey (Yédomonhan and Akoègninou, 2009). Several communities in Africa make use of the honey bees themselves for medicines. For example in Burkina Faso both honey and honey bee brood (larvae) are widely used to treat a range of ailments (Meda *et al.*, 2004). Analyses of honey used by the Hadza people in Tanzania has shown that it does have higher protein, fat and ash content that is thought to be related to the inclusion of bee brood when harvested/consumed (Murray *et al.*, 2001).

For Petalangan people in Indonesia, bees are seen as a symbol of health and cheap sustenance (Titinbk, 2013). Many indigenous peoples across Asia use honey as a medicine, mixing or cooking the honey with other ingredient. For example the Siddhi tribes used *Momordica charantia* leaf juice together with few drops of honey as cough medicine, and for congestion and chest pain for children (Joseph and Antony, 2008). Local people in Kalla Chitta of Pothwar region in Pakistan used a decoction of *Cicer arietinum* (chick pea) fruit mixed with honey to relieve abnormal menstruation and throat pains. Honey is also used by these people to relieve other pains such as chronic flu, sunstroke, antidiabetic and chronic constipation (Arshad *et al.*, 2014).

5.3.6 Social relations: song, dance, art, story, rituals and sacred knowledge about pollinators

Indigenous peoples and local communities value pollinators through texts, song, dance, art, religious and spiritual knowledge, and revelations **(Case example 5-15)**. Stingless bees are also present in popular songs and in the Brazilian imagary (Souza *et al.*, 2013). Near Pedu Lake, in the Kedah province of northern Malaysia near the border with Thailand, honey hunters chant ancient prayers as they gather honey from giant tualang (*Koompassia excelsa*) trees (Buchmann and Nabhan, 1996). The Burmese and Thai people believe that if bees move to their house, it is a sign of luck and prosperity (Chantawannakul *et al.*, 2011).

The O'odham people from the Sonaran Desert of southern Arizona and northern Mexico have a song about the intoxicating effects of thornapple (*Datura* sp.) alkaloids on nectar-feeding hawkmoths (*Manduca* spp.), first recorded in 1901, although undoubtedly of much greater antiquity. The real value of such songs is highlighted by scientific investigations to understand this intoxication, which was 'discovered' by science in 1965, challenging theory about the level of alkaloids in nectar (Nabhan, 2000).

CASE EXAMPLE **5-15**

VALUING POLLINATORS THROUGH SONG AND CEREMONIES

Location: Indonesia and Philippines
Palawan and other indigenous people

The Palawan people (Philippines, Upland Palawan) pass on knowledge about the stinging bee (*Apis florea* or *Apis cerana indica* called *mugdung Nigwan* or *tämaing*) and stingless bee (*Trigona* 'sensu lato' probably called *kätih kätih*) through ceremonies. Both *tämaing* and *kätih kätih* are associated with many myths, legends, rites, and others ceremonies. They have specific rituals requesting god *(ampuq)*, to allow flowering and blossoming of the flowers to take place, then invite the bees to come and build nests and produce honey.

Songs are always sung to pass on knowledge while harvesting honey in the East coast of North Sumatra (Hadisoesilo and Kuntadi, 2007). The first song is sung before climbing a tree to introduce oneself to the tree and the spirits in that tree. The second song mollifies the bees in order for them to become gentle and provide larger quantities of honey. In Danau Sentarum National Park, West Kalimantan, climbers sing mantras at different stages of the honey collection (Hadisoesilo and Kuntadi, 2007). When the ladder is ready, they welcome its strength. Once on the branch, while smoking the bees, they sing again to appease the spirit of the tree, and when cutting the comb, they welcome the upcoming harvest. Once honey is harvested, they ask their ancestors to protect the basket in its descent. One last song marks the end of the harvest, the final descent of the climbers and the return to the village (Césard and Heri, 2015). Parts of the lyrics are improvised, not without humor (often as honey alludes to a beautiful young woman and to her charms) (Mulder *et al.*, 2000).

The Ikpeng group in the Brazilian Amazon sing a song of a bee to avoid thunder during storms. They say that this song is very dangerous and should not be sung when there are no storms (Athayde, 2015). Ogiek songs and prayers relay all the knowledge about how to care for the forest; learning is in the circle of life (Samorai Lengoisa, 2015).

Pollinators in ancient and modern Mesoamerican civilization have divine affiliations. For instance hummingbird feathers were believed to be the seed from which a major deity among the Aztec was born, the war god *Huitzilopochtli* (Spence, 1913 [2010]). Today hummingbirds are seen as sacred creatures capable of communicating with the gods **(Figure 5-23)**. Similarly, bats were seen as messengers from the underworld and symbols of fertility (Retana-Guiascón and Navarijo-Ornelas, 2012). Ancient Mayan rituals in relation to bees have continuity with today's requests for the protection of hives, of a good honey harvest and good fertility in the flowers that feed the bees. These rituals support continuity in production, consumption and offering of drinks sweetened with honey (sacá and balché) that are also given to birds that are sacrificed (González and Noguez, 2009). Stingless bees are part of the cosmogony and mythology, being of similar importance to the cultivation of maize, the staple food for Mesoamerican civilizations (de Jong, 2001). Within the mythology U'wa (Sierra Nevada del Cocuy, Colombia), bees are considered important as the beings that made possible the gestation of the life and natural light in the universe, and honey is associated with purity, vitality, strength, fertility and procreation (Falchetti and Nates-Parra, 2002). Lima and Moreira (2005) report that the Tupinambás people in Brazil associate stingless bees with their cosmology, and name constellations with bee names.

5.3.7 Governance by, with and for pollinators and their spiritual presences among indigenous peoples and local communities (holistic valuation)

Governance has been defined as:

> the interactions among structures, processes and traditions that determine how power and responsibilities are exercised, how decisions are taken and how citizens and other stakeholders have their say (Graham *et al.*, 2003).

FIGURE **5-23**

Hummingbirds, pollinators with divine affiliations.

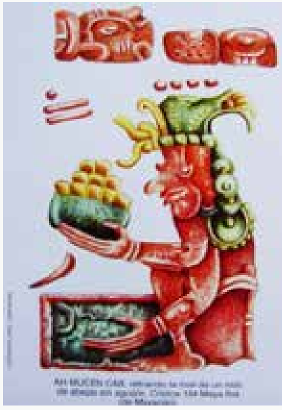
A) The Spine Peak Blackback (*Ramphomicron dorsale*), endemic species from the Sierra Nevada de Santa Marta, Colombia.
© Proaves, Alonso Quevedo. Reproduced with permission.

B) Humming bird *Eriocnemis mirabilis*. Endemic Bird of the cloud forest of the Pacific slope of the Cordillera Occidental de Colombia. Series Stamps: Biodiversity endemic of Colombia in danger of extinction. Issued in 2015.
Reproduced with permission.

FIGURE **5-24**

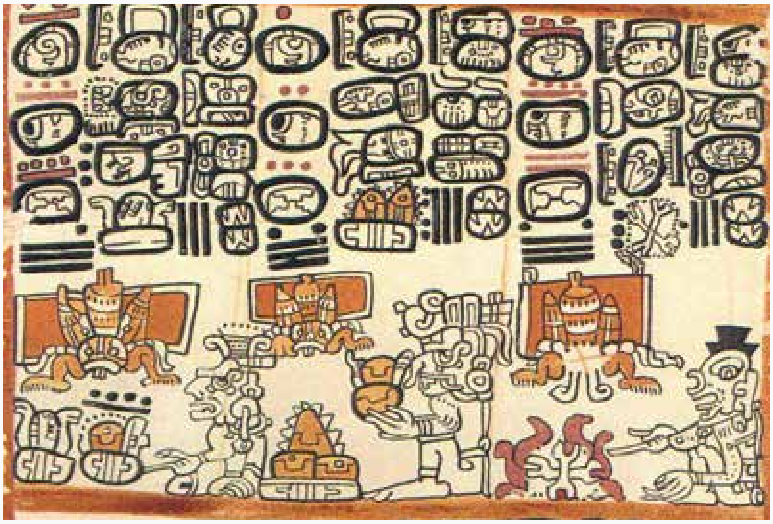
Mayan Codex and art representing Xunan Kab (*Melipona beecheii*).

A) Ah Muzen-Cab, God protector of bees and the crops.
© Luis A. Medina. Museo Palacio Cantón, Merida, Yucatán. Reproduced with permission.



B) Ah Mucen Kab by removing honey from a nest of stingless bees. Codice 104 Maya Itzá of Mayapán.
© Juan C. C. Medina. Reproduced with permission.

C) Parts of the Mayan Codex and the bee (Melipona beecheii)



CASE EXAMPLE **5-16**

SOCIAL ORGANIZATION OF BEES AS A MODEL FOR HUMAN SOCIETY AMONG PRE-COLUMBIAN MAYA PEOPLE

Location: Mesoamerica

Mayan peoples

Evidence of the economic and religious importance of the bee *Melipona beecheii (Xunan-Kab)* is seen in the various manifestations of Mayan art that have reached us. The most important is the codex of Madrid, one of the three surviving Maya codices, in which stylized images of *Xunan Kab* bees and their guardian gods are represented in various scenes probably associated with the harvest of the honey and colony multiplication (pages 103-112). Some of these deities are *Ah-Mucen-Kab* (the descending honey god), *Noh Yum Kab*, *Hobnil*, *Balam-Kab* and *Moc-Chí* **(Figure 5.30 A and B)**. All of them are represented with a mixture of anthropomorphic and bee-like features, sometimes involving characteristics of other sacred animals like the jaguar (de Jong, 1999; Quezada-Euán *et al.*, 2001) **(Figure 5.30 C)**. The Mayan *Miatschahales* (philosophers) used stingless bee (*Melipona beecheii*), as a model for adequate social organization as well as ecological and political ethics. Thus, several values and strategies are explicitly modelled on *Melipona beecheii´s social organization. Among these are: cooperation and solidarity; adaptation to changes that occur outside the colony; optimization of the use of natural resources for the well-being of the group over individual well-being; avoidance of over-exploitation of natural resources; control of population size to adapt to variable conditions; prediction of droughts; and food security measures* (López-Maldonado, 2010; *López-Maldonado and Athayde*, 2015).

In many ILK systems, these interactions place pollinators in key roles with ultimate authority for governance. Pollinators including birds, bats, butterflies, bees and other insects feature as spiritual presences and symbols of authority amongst indigenous peoples and local communities across the world (Kristsy and Cherry, 2000; Werness, 2006). Pollinators' spiritual and symbolic significance and authority in social organization is well documented amongst Native Americans, on both northern (Sturtevant, 1978; Fogelson and Sturtevant, 2004) and southern continents **(Case example 5-16)**.

Bee deities are important among ILK holders in Asia (Gupta *et al.*, 2014; Césard and Heri, 2015). For example, Punan honey hunters in Borneo express the respect that they carry for bees by referring to them as "Hitam Manis", "Blooming Flowers" or "Fine Friends", and indicate their subservient relationship by referring to themselves as the Dayang, the handmaidens of Hitam Manis (Buchmann and Nabhan, 1996). Dressler (2005) presents great detail about the governance of the Tagbanua swidden-honey complex by spiritual presences of "bee deities" **(Case example 5-17)**. Dressler (2005) recommends these Tagbuana knowledge and beliefs as the basis of involving Taganuan in management of the Puerto Princesa Subterranean River National Park, and recognition of their ancestral title.

In Andean communities, the concept of "Buen vivir" values solidarity, community, freedom, respect for nature, responsibility and equality, and emphasizes the links between good governance and relations with nature, of the good life and the rights of nature (Fatheuer, 2011). These principles underpin the indigenous Potato Park, which is protecting genetic diversity and pollination-based reproduction associated with approximately 1,300 different varieties of potato (Argumedo and Pimbert, 2005). In the Siddhi tribes in Uttar Kannada (India), honey harvesting is valued for its social institutions that require and teach good teamwork among the harvesters (Kumsa and Gorfu, 2014).

Governance systems also recognize tenure, systems of ownership, over important pollination resources. In Indonesia, there are diverse rights associated with trees that have bees nesting on them (Césard and Heri, 2015). In Tesso Nilo National Park, Riau Province Indonesia, the local beekeeper association marks the coordinates of each honey tree (sialang) owned by their members. In Sumatra and Kalimantan, honey bee trees belong to the first person who found the trees and the ownership is inherited to the children. In Dompu, Sumbawa, the trees are owned by the village authority, but after each harvest season, the trees are open for bidding. In Ujun Kulong National Park, West Java, there is no ownership of the trees and everyone is entitled to

CASE EXAMPLE **5-17**

SINADA, THE BEE DEITY, AND CEREMONIES GOVERN THE SWIDDEN-FOREST-HONEY COMPLEX

Location: Palawan Island, Philippines and Indonesia
Tagbanua, Palawan and Patalangan indigenous peoples

Tagbanua people of Palawan Island believe that the ultimate authority for their swidden-honey complex lies with two bee deities, *diwata* and *panya'en*, living in the forest and karst (towers, cliffs and ridges of limestone). Both spirits take the shape of bees, and among them is Sinada, the highest ranking bee deity. Communication with these spirits occurs through the babalyan (senior cultural leader, shaman) who conducts ceremonies and prayers that express hope and security to Sinada. "Sinada thus governed the social order and function of the bee kingdom while offering honey collectors strength and fortitude. *Sinada's* subordinate is the *panya'en*, *Ungao*, the creator and guardian of honey bees in Cabayugan. *Ungao* transmitted *Sinada's* "message of assistance" as laws instructing other spirits to influence the behaviour of honey bees. *Ungao* asked his subordinates to "convince" bees to build hives visibly and in permanent locations" (p. 25-26) (Dressler, 2005).

The Palawan people of Palawan island view bees (and their products) as something that needs to be negotiated through appropriate behaviour and ceremonies. They conduct the *Simbung* ceremony to ask the Gods for the flowering of trees. The Palawan people see that the decline of bees and their products will negatively impact on the ceremony, and on the skills, knowledge, and mythological connections and awareness of the next generation of Palawan people and vice versa (Novellino, 2002).

Amongst the Petalangan community, Indonesia, the rituals of bee-hunting have created social groups based on their functions during the collection process. The collector group, known as a *menumbai*, consists of several people with different roles and responsibilities. The *juragan tuo* is the coordinator of the harvesting team, usually someone who is older, with significant experience in harvesting honey, and substantial knowledge about the bees, their behaviour and the habitats of the trees. The *mudo* is an assistant to the *tuo*, always someone who is younger with less experience. The *juragan tuo* passes knowledge on to *juragan mudo* who will climb the trees, and *tukang sambut*, the receiver of the honey, at the bottom of the trees. The bee-hunting activities enhance cooperation supported through rituals and cultural ceremonies. Distribution of the honey is determined by membership of the social groups, with between 20-40% for the *menumbai group*/harvester (40-60% for the rest of the communities and 20% for the head of the village (Buchmann and Nabhan, 1996).

gather honey on any trees they find (Césard and Heri, 2015). Land tenure systems based on ILK are often complex, with overlapping rights enabling access to resources with sets of checks that contribute to ensuring that pollinators' resources and pollination resources are not over-exploited (Ostrom, 2003, 2005). For example, in the Cordillera of the Philippines tenure regimes include communal, corporate and individual lands (Prill-Brett, 1986, 2003).

5.4 IMPACTS, MANAGEMENT AND MITIGATION OPTIONS

5.4.1 Risks to nature's benefits to people and good quality of life

The contribution of pollinators and pollination to nature's benefits to people and good quality of life, assessed through socio-cultural and holistic valuation approaches, are clearly very high (5.2, 5.3). Risks associated with pollinators and pollination therefore will potentially impact on these benefits and quality of life. Chapter 6 presents a summary of the risks and opportunities associated with pollinators and pollination **(Table 6.2.1)**, and provides relevant responses organized across sectors. Here we focus on those risks most relevant to the instrumental and relational types of values of pollinators and pollination considered in this chapter **(Tables 5-1 and 5-2)**. Four main risks will impact on these values **(Table 5-3)**.

Losses and declines in nature's benefits to people and good quality of life have been evident in the past as well as the contemporary context. For example, a pollinator extinction is associated with a cascade of impact on quality of life for Easter Islanders:

The Polynesian rat (*Rattus exulans*), which arrived on Easter Island with the Polynesians, may have caused the extinction of a parrot species that once pollinated a now extinct *Jubaea* palm (Van Tilburg, 1994; Diamond, 1995; Robert *et al.*, 1998). The rats also destroyed palm and other tree seeds, diminishing the native forest until the Polynesians could no longer construct canoes for fishing; thus the subsequent cultural decline may be more of a result of pollination disruption to seedling recruitment than of human overexploitation of forest resources (Cox and Elmqvist, 2000).

Contemporary impacts of pollinator and pollination declines on nature's benefits and good quality of life are being highlighted by organisations such as Greenpeace[17], and National Geographic (Holland, 2013), and Time (Pickert, 2008), for example the loss of appreciation of the beauty of butterflies[18]. Wider issues of loss of aesthetic value of landscapes (Farber *et al.*, 2006), and of inspiration for art, music, and literature are key concerns, reflected for example in the Faith Taskforce and publications of the North American Pollinator Protection Campaign[19] and

17. http://sos-bees.org/
18. http://www.learner.org/jnorth/tm/monarch/ConservationValuesBrowerQA.html
19. http://pollinator.org/nappc/index.html

TABLE **5-3**
Risks and impacts on values

Risk	Impacts on values assessed through socio-cultural and holistic approaches in this chapter
Direct and indirect impacts on food crop production	Decline in human health and nutritional security due to less availability of crop plants that are major contributors to micronutrients, vitamins and minerals in the global human diet.
Direct and indirect impacts on honey production and bee numbers	Declines in rural economies that are anchored by beekeeping and honey hunting as livelihoods with many advantages (e.g., low investment, links with cultural institutions). Declines in educational and recreational benefits derived from beekeeping and honey hunting (e.g., as an intervention tool for youth criminal behaviour).
Loss of distinctive ways of life, cultural practices and traditions in which pollinators or their products play an integral part	Loss of nature's benefits to people from declines in pollination-dependent products used in medicines, biofuels, fibres, construction materials, musical instruments, arts and crafts. Loss of cultural services through declines in pollinators and pollination as sources of inspiration for art, music, literature, religion and technology. Declines in nature's gifts to Indigenous Peoples and Local Communities of pollination-promoting practices of valuing diversity and fostering biocultural diversity and of their diversified farming systems.
Loss of distinctive ways of life, cultural practices and traditions in which pollinators or their products play an integral part	Loss of nature's benefits to people from declines in pollination-dependent products used in medicines, biofuels, fibres, construction materials, musical instruments, arts and crafts. Loss of cultural services through declines in pollinators and pollination as sources of inspiration for art, music, literature, religion and technology. Declines in nature's gifts to Indigenous Peoples and Local Communities of pollination-promoting practices of valuing diversity and fostering biocultural diversity and of their diversified farming systems.
Loss of aesthetic value, happiness or well-being associated with wild pollinators or wild plants dependent on pollinators	Loss of good quality of life from declines in the availability of pollinators and pollination resources as globally significant heritage, as symbols of identity, as aesthetically significant landscapes, flowers, birds, bats, and insects, and for their roles in social relations and governance interactions of Indigenous Peoples and Local Communities.

the Sentimiel initiative of the Institut de recherche pour le développement[20].

5.4.2 Peoples' experiences of declines and associated drivers

People in many parts of the world have reported declines of pollinators and pollination. Chapter 2 provides a scientific assessment of the drivers of the change to pollinators and pollination, together with examples of contributions from ILK systems. Here we provide an overview of how people have experienced these declines, and the drivers of declines.

People's experiences are associated with environmental, socio-economic and cultural change including: habitat loss, fragmentation and degradation; pesticides and herbicides; changes to and loss of bee management practices and knowledge; loss of access to traditional lands; changes to and loss of bee management practices; loss of access to traditional estates; changes to and loss of traditional knowledge, tenure and governance systems that protect pollination; and pollination governance deficits. Often the decline of pollinators and the decline of ILK systems occur simultaneously as a result of the expansion of agriculture and commodity extraction frontiers, and associated habitat loss and territorial acquisition (Reyes-García *et al.*, 2014b).

5.4.2.1 Habitat loss, fragmentation and degradation

Many peoples' experiences of pollinator and pollination declines are associated with habitat loss and degradation, including replacement of biodiverse habitat with monocultures (Athayde, 2015). Co-production between science and ILK is strengthening understanding of these declines, for example identifying how declining bird populations associated with transformation of traditional shaded coffee agriculture to simplified systems with fewer trees or treeless monocultures, referred to as sun coffee, result from this destruction of wintering habitat for millions of migratory birds (Perfecto *et al.*, 2014). Guna people have noticed the disappearance of both a hummingbird that pollinated hibiscus flowers, and the hibiscus flower itself, the syrup of which was formerly used as a drink by pregnant women (López *et al.*, 2015).

In Brazil, the agricultural frontier expansion is putting pressure on both demarcated indigenous lands and other forests, driving a "containment" of bee populations in smaller forest fragments (Villas-Bôas, 2015). The Kechifo people from Kafa (Ethiopia) harvest three types of honey, each associated with a particular plant, and consider one of them, white honey, as a marker of biodiversity decline — white honey disappears with the introduction of monospecific crops of coffee trees (Verdeaux, 2011). In Kodagu (India), once famous for abundant honey projection, intensification of coffee plantations has reduced populations of melliferous plants, particularly *Litsea floribunda*, to such an extent that honey production is now only symbolic (Barlagne *et al.*, 2009). Honey hunters in India note both forest fires and forest loss as causes of declines in honey availability (Demps *et al.*, 2012a). Honey-harvesters in Sentarum Lake, Indonesia report that smoke coming from the deforestation for plantations has a direct negative impact on the arrival of the swarms in season and therefore on honey production (Césard and Heri, 2015). Degradation of habitat extends to direct impact on pollinators, such as through over-hunting of large flying foxes (*Pteropus vampyrus natunae*) in Central Kalimantan, Borneo, Indonesia (Struebig *et al.*, 2007).

5.4.2.2 Pesticides and herbicides

Pesticides have also been associated with declines. Beekeepers in the United States of America (USA) have reported wide-spread deaths of honey bees, and the phenomenon termed colony collapse disorder (CCD) (Suryanarayanan and Kleinman, 2013). While the US beekeepers' perspectives on the causes of CCD are heterogeneous, several commercial beekeepers with decades of migratory beekeeping experience claim experiential and practical knowledge that CCD is caused by proximity of their hives to agricultural crops treated with neonicotinoids such as imidacloprid. Beekeepers in Europe and France have similarly attributed colony losses to this same group of insecticides (Suryanarayanan and Kleinman, 2014; Suryanarayanan, 2015).

Beekeepers in Burkina Faso note a direct link between increased cotton production and declines of honey, which they similarly attribute to pesticides (Gomgnimbou *et al.*, 2010). Sichuan pear producers in Hanyuan County in China have adopted hand-pollination as insect pollinators have disappeared due to the use of herbicides and pesticides (Ya *et al.*, 2014). In Korea, one survey of traditional beekeepers found that 94.7% had experienced damage to their bee colonies from pesticides, and considered pesticides the most critical problem in apiculture, one that they cannot escape (Choi and Lee, 1986; Park and Youn, 2012). Honey hunters in India related declines in honey to pesticides on coffee estates (Demps *et al.*, 2012a).

Mbya Guaraní, peoples from the Paraná State of Brazil have noted pollinator declines associated with use of pesticides (Cebolla-Badie, 2005). Tūhoe Tuawhenuaare are concerned about many chemical residues posing a threat to pollination and pollinators, and through co-production with science have identified that the pesticide '1080' is taken up into

20 https://en.ird.fr/content/download/63580/513428/version/3/file/excellence_in_research_2012.pdf

their medicinal plants, with unknown effects (Doherty and Tumarae-Teka, 2015).

5.4.2.3 Changes to and loss of bee management practices and knowledge

A recent global review across Mexico, Costa Rica, Brazil, Africa, Australia and Asia found that stingless beekeeping is disappearing in some areas, such as the Yucatan. In other places, such as Brazil, meliponiculture is increasing as an important secondary economic activity (Cortopassi-Laurino *et al.*, 2006). The traditional use of stingless bee products in medicine and handcraft is also declining (Sterman *et al.*, 2008; Roig Alsina *et al.*, 2013). In Colombia, stingless beekeeping practices are being challenged by loss of local names, abandonment of hives due to mismanagement, and homogenization and standardization of bee species and beekeeping techniques (Rosso-Londoño, 2013). The disappearance of stingless beekeeping from indigenous communities is problematic (Villanueva-Gutiérrez *et al.*, 2013), as it may represent a threat to the survival not only of various native bee species but also to the sustainability of the ecosystems due to their contribution as pollinators and also to ancient medicinal and cosmological traditions, and other cultural aspects (González-Acereto *et al.*, 2006). Some species of stingless bees like *Melipona beecheii* in the Yucatan find their most important populations in the hands of Mayan farmers, as large trees from the central Yucatan have disappeared, resulting in the absence of feral colonies of this species in such areas (González-Acereto *et al.*, 2006). The survival of *M. beecheii* in the Yucatan strongly depends on the continuity of stingless beekeeping.

Stingless beekeeping decline is affected by multifactorial trends, involving ecological, social and economic drivers, such as the greater commercial returns from the introduced honey bee (*Apis mellifera*) (Cortopassi-Laurino *et al.*, 2006). Loss and decline of the stingless bees in also linked with a loss of traditional knowledge and practices, including cosmogony and ethnomedicine, and associated loss of biocultural diversity (Joshi and Gurung, 2005; Ngima Mawoung, 2006; Freitas *et al.*, 2009; Corlett, 2011; Césard and Heri, 2015; Samorai Lengoisa, 2015; Villas-Bôas, 2015). Key bottlenecks to increasing stingless beekeeping include how to collect and conserve their honey, how to rear them in large quantities, how to prevent impacts from pesticides and maintain the bees, and how to provide qualified information and training in all levels (Cortopassi-Laurino *et al.*, 2006). Co-production between ILK and science is proving effective in overcoming some of these challenges **(Case example 5-12)**.

Traditional beekeeping knowledge and practices are also declining in Europe. For example, in Sicily the "férula" hive is known to be strong and not expensive, but was progressively replaced with frame hives, and traditional knowledge such as the "partitura" used by Sicilian beekeepers to recognize an artificial swarming is also declining (Roussel, 2009).

Honey hunting among forest-dwelling communities who hunt at low levels in Kenya, Indonesia, Nepal, India, Brazil and Cameroon and practice non-destructive methods supports protection of pollinators and pollination resources (Joshi and Gurung, 2005; Ngima Mawoung, 2006; Rosso-Londoño, 2013; Césard and Heri, 2015; Samorai Lengoisa, 2015; Villas-Bôas, 2015). However a large rise in unsustainable honey hunting is now posing a significant threat to stingless bees in Asia (Corlett, 2011) and the neo-tropics (Freitas *et al.*, 2009). The demand for wild nests to deliver honey, resins and cerumen for food, medicines and other products has led to honey hunters now being targeted as one of the main causes of loss of bee colonies and of destruction of habitat trees. However, Rosso-Londoño's (2013) socio-environmental analysis identified that there are now many other stakeholders, including stingless beekeepers, research and government institutions, and industry, because markets and new projects (for production, education, hobby and even research) are part of the context that is driving the demand for wild nests. Among Indonesian honey hunters, changes are occurring at the social-cultural level and interacting with environmental change. For instance, Anak Dalam people in Sumatra are using honey as an exchange value (non-monetary) to buy other necessities, such as food, that are not available in the forest (Ibrahim *et al.*, 2013) (see also 4 7.1). Local knowledge guarded by the indigenous communities is disappearing, or beginning to be ignored. Natural habitat that used to be preserved (i.e. *sialang* trees as an indicator for preservation of habitat) and is believed to be the source of life, is now being replaced by widespread plantation and development (Césard and Heri, 2015).

5.4.2.4 Invasive species

Invasion by Africanized bees is perceived as a particular risk for Guna people in Panama, as they killed a number of people since they arrived more than twenty years ago. Elephant grass (*paja canalera, Saccharum spontaneum*) is an aggressive alien grass also causing problems; it is the main cause of the degradation of the soil due to the fires and the decline of forested and agricultural landscape (López *et al.*, 2015). Among the Kayapo in Brazil, the invasive *Apis mellifera* scutellata (African bee subspecies) was initially considered highly problematic due to its aggressiveness and competition with native bees, but after two decades it came to be recognised as the strongest bee who takes care of other bees (Posey, 1983a). Mbya Guaraní, peoples from the Paraná State of Brazil, have noted that the exploitation of the introduced Western honey bee (*Apis* *mellifera*) is impoverishing their ecosystems and decreasing honey yields from native bees (Cebolla-Badie, 2005). Māori people in New Zealand believe that the introduction of exotic invertebrates and vertebrates has caused major declines in pollinator communities over the last 75 years, for example through introduced possums eating flowers (Doherty and Tumarae-Teka, 2015). On the other hand, feral bees became an important part of the Tuawhenua way of life, providing honey that was used for old people, honoured guests and babies, until their decline in the 1990s. Introduced plant species are also noted as supporting some native birds with floral and fruit resources (Doherty and Tumarae-Teka, 2015).

5.4.2.5 Climate change

Climate change affects Indigenous peoples and local communities' relationships with pollinators (Athayde, 2015). In the Himalayas, Kullu beekeepers have noted changes to swarming times and population sizes, with every season occurring about one month earlier. Pest levels are higher due to drought conditions, and the quality of seed production is adversely affected by lower bee populations (Sharma, 2004). In central America, Guna people have noticed that birds once restricted to latitudes south of Ecuador are now arriving in Panama, bringing with them the plant species that they eat. On the other hands, a bird that their grandparents' generations used as warnings of danger at home are no longer seen, which they attribute to climate change-driven migrations. Climate changes is also changing the timing of biotemporal signals of when to plant and harvest, changing the agricultural calendar (López *et al.*, 2015).

5.4.2.6 Loss of access to traditional territories

Indigenous groups have also lost access to their traditional territories, leading to a decline in traditional bee management practices (Césard and Heri, 2015; Samorai Lengoisa, 2015).

Ogiek people of Kenya, whose migratory patterns follow the production of different bees from the lowlands to the highlands, have now been excluded from access to rock- and ground-nesting bees because their traditional lowlands forests have become part of Lake Nakuru National Park (Samorai Lengoisa, 2015), causing serious and sudden loss of biocultural diversity, language and traditional practices. They believe this exclusion to be unlawful. Māori people acknowledge that individuals negotiating land settlements of behalf of their people are required to give up their lives and also those of their families for the fight, losing the time to connect with land, people and culture, and to pass on ILK, in the process (Doherty and Tumarae-Teka, 2015).

5.4.2.7 Changes to and loss of traditional knowledge, tenure and governance systems that protect pollination

Substantial research on traditional knowledge has identified loss and decline as small-scale societies became more integrated within nation-states and the market economy (Gómez-Baggethun and Reyes-García, 2013; Oteros-Rozas *et al.*, 2013). These losses extend to declines in knowledge about pollination-related agricultural and management practices, for example of knowledge of flowering plants that attract pollinators (Reyes-García *et al.*, 2013a). Amongst Māori, the rural-urban migration in the 1950s, driven by economic and environmental change, took many people away from their elders, customs, and practices, driving loss of ILK relevant to pollination (Doherty and Tumarae-Teka, 2015).

More recent studies have focused attention on the dynamic nature of traditional knowledge, so that while specific bodies of knowledge have undoubtedly been lost, where societies retain the ability to generate, transform, transmit, and apply knowledge, traditional knowledge retains a vital role, for example in retaining land races and fruiting trees that foster a diversity of pollination resources alongside commercial varieties in home gardens and agroforests in Spain, Portugal and Mexico (Castro-Luna and Galindo-Gonzalez, 2012; Reyes-García *et al.*, 2014a; Vallejo *et al.*, 2014; Vallejo *et al.*, 2015). The types of (secular) ILK that are retained also adapt to the context (Reyes-García *et al.*, 2013b). Governance and tenure arrangements strongly influence whether or not societies are able to generate, transform, transmit and apply their traditional knowledge. Both governance and tenure are also experiencing declines and disruptions in diverse developed, emerging and developing economies (Hill *et al.*, 2012; Mannetti *et al.*, 2015; Tang and Gavin, 2015).

National law and development projects focused on agricultural production, rural development and nature conservation have led to breakdown of tenure systems and fragmentation of governance arrangements that are vital to shifting agriculture and other practices that protect pollination, even where some recognition of land rights occurs, for example in the Bolivian Amazon and the northern Philippines (Prill-Brett, 2003; Reyes-García *et al.*, 2014b). Traditional diverse farming systems are threatened by lack of payment for the non-market ecosystem goods and services they provide, out-migration of farmers due to economic crisis and opportunities elsewhere, and cultural erosion (Koohafkan and Altieri, 2011). In southern Madagascar, the World Bank's clearing and plowing the land campaign undermined the Tandroy people's social-ancestral relationships that govern practices including protection of forests with bees that serve as pollinators of nearby bean crops (von Heland and Folke, 2014). In relation to intellectual property, national copyright law allows aappropriation of Native American imagery and symbology for sporting and other mascots, leading to a loss of cultural values associated with pollinators. Native Americans have pursued legal challenges to this appropriation, but the issues are not resolved and remain controversial (Johansen, 2007; King, 2013).

5.4.2.8 Pollination governance deficits

The International Risk Governance Council (IRGC, 2009) has identified governance deficit arising because the threats to pollination and related risks are not adequately taken into account in policies and regulations that may affect pollinators and their services. Their review of the current regulatory and governance context identified the main deficit is that most regulations that affect pollinators and pollination are not specific to pollination (IRGC, 2009). Their report then focuses on five particular aspects of governance deficits: uncertainty of science; lack of adequate economic schemes to internalise environmental costs; absent or inadequate land use policies; inadequate stakeholder participation and consultation; and difficulty of medium- to long-term planning. Chapter 6, section 6.2.1.2, summarises the progress towards reducing these barriers, and additional responses.

Here we consider impacts that result from the overall deficit in pollination risk governance, the lack of specificity to pollination. Governance of pollination extends across many sectors such as agriculture, trade, nature conservation, and encompasses the complex roles of, and power relationships between, for example, civil society, governments, the private sector, indigenous peoples and local communities from local to nation-state to global scales (IRGC, 2009). While governance has many definitions and indicators (Ernstson *et al.*, 2010), in this context of lack of specificity, the Graham *et al.* (2003) definition is useful, as it highlights *interactions,* and these pose both risks and opportunities in pollination governance (0). For example, Ernston *et al.*'s (2010) empirical analysis of the governance of pollination and seed dispersal services in Stockholm highlighted how interactions lead to key risks including highly contested land use, numerous, fragmented multi-level administrative units that trigger under-valuing of pollination services, marginalization of key actors oriented to protection of pollination, scale mis-matches, networks that cross scales but do not span (e.g., cemetery managers do not link with allotment gardeners), and low levels of flexibility for adaptation.

Analysis of pollination governance within the European Union identified problems from (horizontal) interplay across sectors, e.g., contradictory goals between agricultural and nature conservation that impact on pollination resources, and from (vertical) interplay between fine-scale cultural variation in motivations and practices that protect pollination and the homogenizing effect to EU directives (Ratamäki *et al.*, 2015). Empirical analysis of the factors affecting farmers' decisions to adopt pollination-friendly practices in coffee plantations identified farmers' perceptions and attitudes, social-location factors, institutions, certification schemes, and markets as powerful drivers across local, regional and larger scales; a conceptual model of these interacting forces was created to provide the foundation for future research into interventions that would enhance pollination (Bravo-Monroy *et al.*, 2015).

5.4.3 Introduction to management and mitigation options

As noted in the introduction, this chapter addresses management and mitigation options as appropriate to different visions, approaches and knowledge systems, of impacts of the decline of diversity and/or populations of pollinators. The concept of *management and mitigation* options is very similar to Chapter 6 concepts of *responses* to risks and opportunities associated with pollinators and pollination, although perhaps with greater emphasis on avoiding situations that create a need to "respond". The Chapter 6 responses focus on the drivers identified in Chapter 2 (see **Table 6.2.3**). Again, many of the people's experiences of declines and associated drivers identified through the assessment for this chapter are the same as, or similar to, those in Chapter 2, but there are several differences. Notable differences include the identification in this chapter of drivers related to loss of access to traditional lands, and changes to and loss of traditional knowledge, tenure and governance systems that protect pollination and pollination governance deficits **Table 5-4**. Chapter 6 does discuss pollination risk governance deficits, but as a response rather than a driver.

Table 5-4 also presents the management and mitigation options considered here in response to these drivers. These options represent a range of integrated responses that focus on minimizing impacts in ways that ensure protection of the many contributions of pollinators as part of supporting nature's benefits to people and good quality of life. Chapter 6 also includes material that is relevant to minimizing such impacts, for example in relation to options such as "diversify farm systems". To avoid repetition, we have included cross-references to relevant material in this chapter in the Chapter 6 text on responses.

As largely integrated responses, the ten options reviewed here generally focus on protecting aspects of both nature's benefits and good quality of life, and address multiple drivers. Nevertheless, there are some differences of emphasis – for example, rights-based approaches respond directly to the driver of lack of access to traditional lands, and biocultural conservation explicitly recognizes ecosystem dynamism and in some cases welcomes invasive species. **Table 5-4** indicates where particular management and

TABLE **5-4**
Similarities and differences between chapter 2 drivers and peoples' experiences of drivers identified in this chapter

Drivers (chapter 2)	Similarity and differences with people's experiences of declines and associated drivers (chapter 5)	Most relevant responses (management and mitigation options) described in this chapter (chapter 6 relevant section)
Land use and its changes (2.2)	Similar: Habitat loss, fragmentation and degradation (5.4.2.1)	Food sovereignty and ecological intensification (6.4.1 Agriculture, agroforestry and horticultural practices)
Pesticides, GMOs, veterinary medicines and pollutants (2.3)	Similar: Pesticides and herbicides (5.4.2.2)	Included in other responses
Pollinator diseases and pollinator management (2.4)	Similar: Changes to and loss of bee management practices and knowledge (5.4.2.4)	Livelihoods and beekeeping (6.4.4 Pollinator management and beekeeping)
Invasive species (2.5)	Some differences: Invasive species People experience these as both declines and gifts (5.4.2.3)	Biocultural conservation (6.4.3 Nature conservation)
Climate change (2.6)	Similar: Climate change (5.4.2.8)	Included in other responses
Multiple interacting threats: • Climate change and land use • Pathogens and chemicals in the environment • Bee nutrition and stress from disease and pesticides (2.7)	Different. People's experiences are mostly of multiple interacting threats that impact widely on their values.	Values and frames approaches to conservation (6.4.6 Policy, research and knowledge exchange across sectors)
Indirect drivers in the context of globalisation • International trade • Increasing human footprint • Shifting pesticides to less regulated countries (race to the bottom) (2.8)	Different. • Loss of access to traditional territories (5.4.2.5)	Rights-based approaches to conservation (6.4.6) Participatory management approaches (6.4.3 Nature conservation)
	• Changes to and loss of traditional knowledge, tenure and governance systems that protect pollination (5.4.2.6)	Biocultural conservation (6.4.3 nature conservation) Knowledge co-production (6.4.6) Strengthening traditional governance systems (6.4.3)
	• Pollination governance deficits (5.4.2.8)	Collaborative governance (6.4.6 Policy, research and knowledge exchange)

mitigation options are relevant to specific drivers, together with the related section in Chapter 6.

5.4.4 Management and mitigation options most relevant to the agricultural sector

5.4.4.1 Food security and ecological intensification

Lack of access to food, and extreme poverty, remain key concerns for many Indigenous peoples and local communities in their relationships with pollinators (Perez, 2015). "Food sovereignty" is an umbrella term for particular approaches to food security that include the ability to determine one's own agricultural and food policies, resilience and ecological intensification. Tackling problems of hunger and malnutrition is thereby linked to the rights of peoples to define and maintain healthy and culturally appropriate food, produced through ecologically sound and sustainable methods grounded in rural livelihoods (Windfuhr and Jonsen, 2010; Sahu, 2011). Food sovereignty is relevant to pollination protection because of its connection with diversified farming systems and management practices that foster diversity and abundance of pollinators and pollination resources Kremen *et al.*, 2012. Food sovereignty focuses on reducing global food trade and reorienting food systems around local production and agro-ecological principles, opposing several of the key risks to pollinators and pollination such as habitat loss, fragmentation and degradation (4) (Wittman *et al.*, 2010; Clapp, 2014). While diverse in its interpretations across the globe, food sovereignty acts as a powerful mobilizing frame for social movements, as well as a set of legal and quasi-legal norms and practices aimed at transforming food and agriculture systems (Edelman, 2014). Food sovereignty emphasizes local initiatives, such as barter markets, that can help overcome the homogenizing effect of globalized corporate economies and trade, recognized as a driver of risks to pollination (Argumedo and Pimbert, 2010; Pirkle *et al.*, 2015).

Food sovereignty is a developing approach that shows the promise of integrating a wide range of positive opportunities, including the quality, quantity, availability, and origin of food, the identity of the producers and styles of farming that have been recognized as pollinator-friendly (van der Ploeg, 2014) (5.2.8). Food sovereignty protects peasant agriculture systems that see agriculture as co-production, i.e., the ongoing interaction, intertwinement and mutual transformation of humanity and living nature. Food sovereignty builds the capacity for enhanced agricultural productivity through social networks that join together interdependent producers and places, and enable sharing of traditional and agro-ecological knowledge, cultivating alternate circuits of exchange, and building urban-rural partnerships (Aguayo and Latta, 2015). van der Ploeg

(2014) describes how these systems of peasant agriculture strengthen the complementary among species, such as between pollinators and plants, as one of their strategies for improving productivity.

Interest in the potential of food sovereignty and ecological intensification to meet food and nature conservation goals is growing (FAO, 2014b) **(Case example 5-18)**. Partnerships that support sustainable and ecological intensification have proven effective in increasing yields, with one study of 286 projects involving 37 million ha and 12.6 million chiefly small-holding farmers showing an average of 79% yield increase across diverse systems (Pretty *et al.*, 2006; Pretty and Bharucha, 2014). Food sovereignty has recently been identified as a key strategy to overcome situations where agricultural trade liberalization leads to increased food insecurity, malnutrition, and exposure to environmental contaminants (Pirkle *et al.*, 2015). In addition, a recent global analysis of nitrogen transfers in terms of functional relationships among crop farming, livestock breeding and human nutrition shows that slight improvements in agronomic performance in the most deficient regions (namely Maghreb, the Middle East, sub-Saharan Africa, and India) would make it possible to meet the global protein requirements with much less international trade (hence more food sovereignty), and reduce N environmental contamination (Billen *et al.*, 2015).

5.4.5 Management and mitigation options most relevant to the nature conservation sector

5.4.5.1 Heritage listing and protection

Identification, listing and protection of heritage values has been established globally since the *Convention Concerning the Protection of the World Cultural and Natural Heritage*[21] was finalized in 1972 and the *Convention for the Safeguarding of the Intangible Cultural Heritage*[22] in 2003. Many nation-states also have their own heritage acts and lists. Several landscapes that are vital to pollinators are already protected; on the World Heritage List; opportunities exist to strengthen the protection of others that are on the Tentative List (e.g., the Tsavo Parks and Chyulu Hills Complex with many bird pollinators)[23].

Preparation of heritage lists generally involves establishment of a set of criteria that must be met in order to qualify for listing. Protection requires development and implementation of a management plan, and ongoing monitoring to ensure that values are being maintained, which includes pollinators' values where they are recognized as part of the significant heritage. The "World Heritage List In Danger" is established when a listed site is losing its values – if the processes of degradation continue, the site will be removed.

The *Convention on the Intangible Cultural Heritage* primarily uses knowledge to achieve its aim of safeguarding the uses, representations, expressions, knowledge and techniques that communities, groups and, in some cases, individuals, recognise as an integral part of their cultural heritage. The Representative List promotes understanding of practices, and management approaches are also listed, for example the protection of traditional knowledge of Totanac people, which includes agroforestry systems that protect pollinators and stingless beekeeping **(Case example 5-19)**. Heritage listing and management activities conducted in ways that empower associated communities can also protect biocultural diversity (Hill *et al.*, 2011a).

21. http://whc.unesco.org/en/about/
22. http://www.unesco.org/culture/ich/en/convention
23. http://whc.unesco.org/en/tentativelists/5515/

CASE EXAMPLE **5-18**

INDIGENOUS POLLINATORS NETWORK TO SUPPORT FOOD SOVEREIGNTY

Location: global (Roy *et al.*, 2016)
Indigenous peoples around the world

The Indigenous Partnership for Agrobiodiversity and Food Sovereignty established the Indigenous Pollinators Network to draw attention to the roles of traditional indigenous production systems of beekeepers, farmers and honey hunters in managing bees. The Network strengthens people to counter the marginalization process these local indigenous knowledge holders face on a daily basis. In particular, the initiative is providing inputs about how the traditional knowledge of indigenous peoples and the work of modern scientists could be linked more equitably and usefully. The network is promoting: bottom-up evidence to value indigenous agroecological knowledge on pollination; identification of good practices for enhanced livelihood opportunities; and awareness raising and knowledge exchange among indigenous communities, for example through learning routes. Case studies underway have highlighted great challenges to traditional practices that maintain pollinators and beekeeping from climate change, proliferation of commercial crops replacing forests, and indiscriminate use of agrochemicals. Many people were concerned that their food security was threatened by pollinator decline, and sought agricultural development based on strengthening their traditional production systems.

CASE EXAMPLE **5-19**

XTAXKGAKGET MAKGKAXTLAWANA CENTRE FOR INDIGENOUS ARTS – BEST PRACTICE CULTURAL HERITAGE MANAGEMENT[24]

Location: Mexico
Totonac people of Veracruz

The Center for Indigenous Arts was established by Totonac people to create an educational institution to transmit their teachings, art, values and culture, while also providing favorable conditions for indigenous creators to develop their art. Totanac people are credited with being the first to cultivate and domesticate the vanilla orchid, and their traditional knowledge and practices include stingless beekeeping and their own agroforestry system, which incorporates diverse pollinators and pollination resources (Alcorn, 1990; Arce Castro *et al.*, 2015). The structure of the centre represents a traditional settlement with separate 'Houses' specialized in one of the Totonac arts, including pottery, textiles, paintings, art of healing, traditional dance, music, theatre and cuisine. At the 'House of Elders', students acquire the essential values and beliefs of the Totonac through integral and holistic transmission of knowledge. The house-schools link each practice to its spiritual nature. This cultural regeneration is renewing Totonac language as the vehicle for teaching, reestablishment of traditional governing bodies, and reforestation of the plants and trees needed for cultural practice, protecting pollinator-pollination webs. The centre also promotes ongoing cooperation with creators and cultural agencies from other states of the country and from around the world.

CASE EXAMPLE **5-20**

LOCAL COMMUNITY PROJECTS TO MAINTAIN WOOD ROSE POLLINATION BY THE LESSER SHORT-TAILED BAT

Location: New Zealand
Local conservation groups and Māori people

The New Zealand lesser short-tailed bat (*Mystacina tuberculata*) is the primary pollinator of the wood rose (*Dactylanthus taylorii*) (Ecroyd, 1996), New Zealand's only completely parasitic flowering plant (La Cock *et al.*, 2005). Both species have seen significant declines. Once widespread, bat numbers have been decimated through introduced predators (rats, stoats, and cats) (Molloy and Daniel, 1995) and today they are thought to exist in less than 5 per cent of their range prior to human settlement (Ministry for the Environment, 2007). The wood rose, popular with woodworkers and historically collected from New Zealand forests, is also chronically threatened and in serious decline (La Cock *et al.*, 2005), due primarily to its consumption by the introduced brushtail possum (*Trichosurus vulpecula*) (Ecroyd, 1996). Protection of wood rose flowers requires cages that excludes possums, but allows bat access (Ecroyd, 1995). Many local groups are empowering the community to take action. The Tongariro Natural History Society has focused on the identification and caging of wood rose plants in the Kakaramea region and the Ngāti Tahu-Ngāti Whaoa Runanga Trust in the Tutukau forest (The Runanga, 2015). The Nga Manu Trust is actively monitoring wood rose and using photography by David Mudge to gain new insights into the plant-pollinator relationship (Balance, 2015). Research by Pattemore (2011) has been a driver for kick-starting a project with wide community support to reintroduce short tailed bats to the Auckland region. Ark in the Park, a project by Forest and Bird (2015) aims to re-introduce wood rose into the Waitakere Ranges near Auckland.

The *Globally Important Agricultural Heritage Systems* list also uses knowledge to promote public understanding, awareness and recognition, and dynamic conservation approaches that concurrently foster nature and culture, sustainable agriculture and rural development. Projects have been established in 19 countries to support national and local stakeholders to develop and implement adaptive management[25].

24. http://www.unesco.org/culture/ich/en/Art18/00666
25. http://www.fao.org/giahs/giahs-home/tr/

5.4.5.2 Participatory management approaches

Globally, there are many good examples of participatory conservation approaches that engage indigenous peoples and local communities in ways that promote socio-cultural values (Borrini-Feyerabend *et al.*, 2004). The Programa para la Conservacion de Murcielagos Migratorios (PCMM; Conservation Program for Migratory Bats) in Mexico provides a mix of research, education, and participation that brings people closely into conservation work. PCMM mobilizes people to protect bat roosts, focusing particularly on the important pollinators lesser long-nosed bats

(*Leptonycteris curasoae*), near where they live, to design management plans, and has helped establish interpretive trails, ecotourism facilities and the local production of bat-based arts and crafts, facilitating people to become local stewards (Withgott, 1999). Local community involvement is helping protect the pollination by bats in New Zealand **(Case example 5-20, Figure 5-25)**.

In Ethiopia, Non-Timber Forest Product and Participatory Forest Management projects support agreement-making between governments and local communities to recognise community rights to use and manage the forest. Interestingly, in one project, government staff initiated on-farm beekeeping to alleviate pressure on forests through alternative, non-forest based livelihoods. Through the partnership with locals, the project team realized that introducing on-farm beekeeping methods was inappropriate, while supporting traditional forest beekeeping keeps people connected with the forest, which is essential for conservation. Instead, the partnership focused on business development systems, developing supply-chain links with traders that have resulted in improved incomes (Abebe and Lowore, 2013). Women in these Ethiopian communities commonly use products of beekeeping, specially make tej (honey wine) and honey beer; opportunities for their great involvement in market activities appear available (Adgaba *et al.*, 2008).

In Nyika National Park, Malawi, mutual benefits have developed from government supporting local people to place beehives in suitable foraging locations within the park; the beekeepers in turn undertake early burning near their hives which protects the forest from later destructive wildfires, and help to see and report poachers (Hausser and Savary, 2009). In Kenya, establishment of a Mau Forest Complex Authority for co-management, and participatory management approach with the Ogiek (as recommended by the Prime Minister's Task Force on the Conservation of the Mau Forest Complex (2009)) would provide a way forward to re-establishing their relationships with bees, the forests, their songs, prayers and vital biocultural diversity.

5.4.5.3 Biocultural approaches to conservation

Conservation of biological diversity, cultural diversity and the links between them is referred to here as "biocultural approaches to conservation". These biocultural approaches to conservation are an emerging field of endeavor building on practice and scholarship in biocultural diversity and heritage, social-ecological systems theory, and different models of people-centered conservation (Gavin *et al.*, 2015). Biocultural conservation is closely linked to endogenous development, that is development based on peoples' own understanding of the world, their priorities, their goals and their historical and cultural contexts (Rist, 2007). Endogenous development recognizes that biocultural actors live and link with both local and global contexts, and thus removes the focus on community-based versus top-down, and replaces it with multi-scalar collaborative practices that connect and find empowerment in both (Hill *et al.*, 2011a). Integrated conservation and development projects, co-management and community-based conservation are examples of methods to facilitate biocultural conservation.

Gavin *et al.* (2015) present a set of principles for biocultural approaches to conservation **(Box 5-3)**. They present the evidence behind the need to adopt biocultural approaches as two-fold: first that numerous international and national human-rights institutions require such approaches; and second that biocultural approaches build capacity for conservation by bringing more actors who are applying more options, with greater likelihood of long-term success.

Biocultural approaches will have different outcomes for pollinators and pollination, as co-evolution and dynamism

FIGURE **5-25**

The New Zealand short-tailed bat (*Mystacina tuberculata*) and the wood rose (*Dactylanthus taylorii*).

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BOX **5-3**

Principles of biocultural approaches to conservation (Source Gavin *et al.*, 2015)

1. Acknowledge that conservation can have multiple objectives and stakeholders.
2. Recognise the importance of intergenerational planning and institutions for long-term adaptive governance
3. Recognise that culture is dynamic, and this dynamism shapes resource use and conservation
4. Tailor interventions to the social-ecological context
5. Devise and draw upon novel, diverse and nested institutional arrangements
6. Prioritize the importance of partnership and relation building for conservation outcomes
7. Incorporate the distinct rights and responsibilities of all parties
8. Respect and incorporate different world views and knowledge systems into conservation planning

CASE EXAMPLE **5-21**

BEEKEEPING TO EMPOWER BIOCULTURAL DIVERSITY AND ENDOGENOUS DEVELOPMENT

Location: Southern Rio Grande do Sul State, Brazil

Four different expressions of family farming and traditional peoples: peasant, agrarian reform settlement, quilombola community, and indigenous Guarani village (Wolff and Gomes, 2015)

Two organisations, Institute of Sociology and Peasant Studies of the University of Córdoba (ISEC), and the Temperate Agriculture Program of the Brazilian Agricultural Research Company (EMBRAPA), worked with these communities over several years toward organization and mobilization of farmers and traditional people to generate organizational structures that supported development of agro-ecological beekeeping systems. Beekeeping systems are understood by members of these communities as important for the production and sale of honey, and for pollination, and particularly because of its influence on their own strategies of organization, participation, empowerment and credibility. For example, the indigenous Gurani people undertake enrichment planting to change the forest so it has more fruits and more honey. Peasants, their representative bodies and the technicians from involved institutions of research and extension, worked together on multi-institutional articulation processes that enabled positive changes in practices used by beekeepers in the field, helping to increase production and productivity of the apiaries. This joint approach contributed to the empowerment of peasants and traditional communities, supported their aspirations for autonomy and food sovereignty, and strengthened the ability to transfer knowledge through greater understanding of the socio-political dimension of agroecology.

are usually welcomed and accepted. Exotic species often become integrated into totemic systems, and afforded the same respect, care and reciprocity as other living beings. This emphasis on accommodating evolutionary processes, rather than managing ecosystems to some past "natural" state is gaining greater support in the scientific community (Carroll, 2011; Hendry *et al.*, 2011). For example, African honey bees and European bees are now recognised as important pollinators in degraded tropical forests of South America and fragmented dry forests of south-eastern Australia respectively (Dick, 2001; Gross, 2001).

Habitat restoration is a frequent outcome of biocultural approaches **(Case example 5-21)**. For example, in the central Mexican states of Guerrero and Tlaxcala, Indigenous Nahuatl and Totonaco farmers from Sierra Norte of Puebla have allied with small farmers to conserve soil, water and biodiversity as they restore pollinators to hundreds of acres of smallholder farmland in their Farmer to Farmer Pollinator Restoration Project (Holt-Gimenez, 2014). Bringing traditional knowledge of bee ecology into the demarcation of tropical forest for protection in South America provides an important opportunity to protect both the critical hot-spots for pollinators and the associated biocultural knowledge of peoples like the Kawaiwete (Villas-Bôas, 2015). Rescue of stingless bee nests, and provision of these to local beekeepers, is helping to mitigate some impacts caused by deforestation in the Amazon basin, Brazil (Costa *et al.*, 2014). Protection of biocultural refugia has been identified as an effective means of enhancing food security and biodiversity (Barthel *et al.*, 2013a, 2013b).

5.4.5.4 Strengthening traditional governance that supports pollinators

Diverse farming systems and ecosystem management practices that support pollinators critically depend on

CASE EXAMPLE **5-22**

WUNAMBAL GAAMBERA INDIGENOUS PROTECTED AREA AND FLYING FOX POLLINATORS

Location: the Kimberley region of north Western Australia
Wunambal and Gaambera Indigenous peoples (Wunambal Gaambera Aboriginal Corporation, 2011

The Wunambal Gaambera people developed their plan for health country by prioritizing 10 targets (cultural or environmental assets) for protection: Wanjina Wunggurr Law; right-way fire; Aamba (kangaroos and wallabies) and other meat foods; Wulo (rainforest); Yawal (waterholes); bush plants; rock-art; cultural places on islands; fish and other sea foods; and Mangguru (marine turtles) and balguja (dugong). Wulo (rainforest) protection highlights protection of pollinator-dependent fruits and a key pollinator, the flying fox.

Wulo has lots of different food and medicine plants, as well as other plants that we use. The main things we collect are gunu (round yam), garnmarngu (long yam) and fruit like gulangi (black plum). Wulo has more different types of plants than the moree (savanna woodland). We also hunt animals in the Wulo, like jarringgu (black flying fox) and diigu (birds) like the nyulbu (Torres Strait pigeon) and collect yinari (scrub-fowl eggs). The jarringgu (flying fox), like lots of other animals, has a special Dreaming story and song about it… Wulo is also a special place for lots of diigu (birds). Gangala (orange-footed scrub-fowl) build big nests on the ground. Mandamanda (rose-crowned fruit-dove) and jurul (emerald dove) also live there.

Wunambal Gaambera healthy country plan sets out how they are going to protect the rainforest through controlling feral animals (crazy ants and cane toads), managing fire and other practices.

unique and complex forms of governance, involving kinship, territoriality, settlement, group membership and identity, gender relations, and leadership and political organization for decision-making (Koohafkan and Altieri, 2011). Policies, regulations and incentives can be used to strengthen these governance systems, and counter the risks posed by economic factors driving outmigration and abandonment of customary institutions. In the GIAHS initiative, although relatively recent, early results show effectiveness in countering economic risks from certification of products, tourism, research underpinning promotion, human resource development, and multi-stakeholder participation in adaptive management projects (Koohafkan and Cruz, 2011; Sun *et al.*, 2011; Son *et al.*, 2012; George, 2013). Endogenous development to strengthen the governance by the Hani and Yi ethnic minorities, which depend on tree worship, has been identified as critical to maintenance of the forests, villages, water channels and rice-terraced agricultural landscapes in Yunnan Province, China (Gu *et al.*, 2012).

Protected areas, long the cornerstone of conservation, are now recognized by the International Council for the Conservation of Nature (IUCN) as existing under diverse governance types (Borrini-Feyerabend *et al.*, 2013). Four different governance types are recognised: (1) government, where a national, provincial or local agency is in charge; (2) shared governance, where collaborative, joint or transboundary arrangements involve a range of different actors in decision-making; (3) private governance, where the protected area is run by an individual owner or organization; and (4) governance by indigenous peoples and local communities. “Indigenous and Community Conserved Areas” (ICCAs) is the term applied to the last category (Borrini-Feyerabend *et al.*, 2013). ICCAs consist of natural and/or modified ecosystems containing biodiversity values, ecological services, and cultural values, voluntarily conserved by indigenous and other communities through local or customary laws. Such areas range in size from <1 ha sacred groves to >30,000 km^2 indigenous territories in Brazil, and are associated with the protection of links between biodiversity and wildlife that ensure pollination (Berkes, 2009; Koohafkan and Cruz, 2011; Sun *et al.*, 2011; Son *et al.*, 2012; George, 2013).

Recognition of ICCAs through effective means, such as inclusion in national reserve systems, can strengthen their sustainability (Berkes, 2009; Kothari *et al.*, 2012; Davies *et al.*, 2013). Governance evaluation and improvement provides a means to strengthen the traditional institutions (councils of elders, clan or tribal chiefs, village assemblies) that ensure ongoing protection and management of pollination and other ecosystem services (Kothari *et al.*, 2012; Borrini-Feyerabend *et al.*, 2013). In Australia, management of ICCAs often starts with identification of key cultural and natural assets (Hill *et al.*, 2011b; Moorcroft *et al.*, 2012). The Wunambal Gaambera people have focused particularly on the protection of the flying fox, an important pollinator of eucalypt trees vital for providing timber used in cultural artefacts (Birt *et al.*, 1997; Birt, 2004; Wunambal Gaambera Aboriginal Corporation, 2011) **(Case example 5-22)**.

In Tanzania, a proposal to exclude beekeepers from forests has been turned around through collaborative workshops recognizing the positive contributions of the local community, resulting in the creation of Bee Reserves **(Case example 5-23)**.

CASE EXAMPLE **5-23**

BEE RESERVES PROTECTED AND MANAGED BY LOCAL PEOPLE

Location: Tanzania

Traditional forest beekeepers (Hausser and Mpuya, 2004; Hausser and Savary, 2009)

The forests of Inyonga area, located between the Katavi National Park, Rukwa-Lukwati Game Reserve and Ugalla Game Reserve, are some of the least disturbed, wild ecosystems in Africa. Beekeeping is traditionally practiced in the area. However, immigration and environmentally destructive activities are posing a threat to these valuable ecosystems. Those responsible for protecting the area were attempting to disallow beekeepers access to the protected area, which in the meantime was being expanded. The Association for the Development of Protected Areas (ADAP) stepped in to assist the Government of Tanzania to tackle the problem. Through a multi-stakeholder workshop the protected area managers gained a much clearer appreciation that beekeeping is environmentally friendly and contributes directly to the effective protection of the whole ecosystem, whilst generating income for local communities, and strengthening local knowledge and skills. 'Goldapis', a Tanzanian company is marketing bee products and developing a highly viable income stream to local people. Bee Reserves were created within the forests that would be protected and managed by beekeepers for their purposes. This provides them with a strong incentive to maintain and manage these forests. The National Beekeeping Policy of Tanzania now includes the creation of bee reserves as a strategy to continue to promote beekeeping within the country, while strengthening forest protection.

5.4.6 Management and mitigation options most relevant to the pollinator management and beekeeping sector

5.4.6.1 Livelihoods and beekeeping

Livelihood approaches, defined here as mechanisms that support peoples' direct utilization of pollinators and pollination resources, can overcome many economic barriers to effective pollinator protection when they are able to link: (1) customary economies (that require ongoing protection of pollinators); (2) markets (that give these products economic significance in the globalized economy); and (3) investments from government in accompanying research, market analysis and brokering, resulting in what has been termed the "hybrid economy" (Altman, 2007). Stingless beekeeping activities are clearly important in both customary and market economies, and are therefore prime examples where government investments in research and brokering can be very effective (Lyver *et al.*, 2015). For example, obtaining organic certification, links to customers prepared to pay for high-value product in developed nations, and strengthening of traditional social organisation and knowledge have greatly improved incomes for beekeepers in Cameroon (Ingram and Njikeu, 2011) **(Case example 5-24)**. In the coffee landscapes of Colombia, producers have obtained the designation as special coffees by Rainforest Alliance, such as the Café Reinita cerúlea produced in the Serranía de los Yariguíes, San Vicente, Santander Colombia. The name of this coffee recognizes that these ecosystems provide habitat for migratory birds such as the Reinita Cerúlea (*Dendroica cerulea*)[26]. The Mesa de los Santos coffee plantation (Santander) is internationally certified by the Smithsonian Institution as a "bird-friendly coffee plantation", because their management is based on organic agriculture practices (CENICAFÉ, 1999).

Across Latin America various efforts are reviving stingless beekeeping through the development of techniques to maintain and reproduce colonies efficiently, to improve the quality and marketability of products for better economic rewards, and increase the value of colonies by additional services such as commercial pollination (Cortopassi-Laurino *et al.*, 2006). Stingless beekeeping is showing signs of recovery for various indigenous groups and local communities of Argentina, Bolivia, Brazil, Colombia, Ecuador, Mexico, and Venezuela. Key elements for the recovery of stingless beekeeping have been: teaching, since many young people have lost the experience from their ancestors and elders; respect for the local costumes and traditions; increased value of products; and development of a market niche for stingless bees products (Cortopassi-Laurino *et al.*, 2006).

Among the "quilombola", a traditional population of descendants of runaway slaves, or "quilombos", the practice of meliponiculture has been carried out for generations and provides an elaborate ecological knowledge based on native bees, the melliferous flora and the management techniques (de Carvalho *et al.*, 2014). Training courses for the "ribeirinhos", traditional populations living near rivers (Kurihara and Cardoso, 2007; Cavalcante *et al.*, 2009), and indigenous groups from the Amazon region have been successful in recovering and strengthening stingless bees rearing practices (Venturieri, 2008a, 2008b). In New Zealand, the introduced European honey bee production from *Leptospermum scoparium* (mānuka trees) that are vital

26. http://www.proaves.org/alternativas-productivas-para-la-conservacion/.

CASE EXAMPLE **5-24**

LOCAL ZAMBIAN BEEKEEPERS GAIN MARKET ADVANTAGE IN THE EU THROUGH ORGANIC AND FAIR TRADE CERTIFICATION

Location: North West Province of Zambia

Local beekeepers (Wainwright, 2002; Malichi, 2007)

The North West Bee Products (NWBP) company of Zambia has 6,500 members, who own the company and ensure its management. In the Zambian North West province, NWBP is the largest employer after the government. All of their honey and beeswax is produced by bees housed in local- style bark hives. Their honey is organic certified (from the UK Soil Association), has fair trade certification from Germany, and meets the EU's stringent import requirements, giving it a comparative advantage on the world market. NWBP began in 1979 with support from GTZ (German Government development organization), and subsequently received support from a variety of donors over the years. The company could not have managed without this support from donors in some years, but is now self-sustaining and successful, with beekeepers annually increasing production, confident in the market for their products. In 2003, NWBP exported 144 tons of honey to the European Union.

The success of this intervention can be attributed to the people's access to all the types of resources needed to make their livelihoods sustainable: natural resources (strong populations of healthy bees and abundant forest); physical resources (trucks able to navigate rough forest tracks and to enable honey to be transported from the producers to the collection centre, buckets with lids allowing clean honey to be transported); social resources (the strong organization, owned and run by the producers and with access to market knowledge); human resources (the beekeepers' skills at beekeeping and honey and beeswax harvesting); and financial resources (access by the company to credit when needed).

CASE EXAMPLE **5-25**

LIVELIHOODS THROUGH BEEKEEPING IN MANGROVES

Location: Guinea Bissau

Local communities in the Bijagos Islands (Hertz, 2009)

In Bijagos Islands, west of Guinea Bissau, honey hunters are attracted by the high productivity of bees in mangroves, particularly the black mangrove *Avicennia germinans*, known as the honey mangrove. It has small white flowers that produce abundant nectar. A Danish project supported local honey harvesters with protective clothing, a smoker, a knife, a bucket and some type of bee brush. Because of the protective clothing, the harvester does not have to kill the bee colony as happened previously. The beekeepers look for wild bee colonies in the mangrove and when a new one is found, it is marked as a sign that it belongs to a beekeeper. One beekeeper can in this way, without any high investment, become the owner of 30 or more bee colonies.

Beekeeping provides one of the few sustainable ways to use mangrove and with these simple protective measures can be done without harming the bees. Beekeeping may exert a positive influence on the forest, through the activities of the bees as pollinators. By ensuring the local people benefit economically from mangrove beekeeping, it is easier to protect the mangroves against total destruction from cutting and burning.

in the Māori pharmacopeia have resulted in a high-value medicinal mānuka honey industry (Stephens *et al.*, 2005).

Strengthening beekeeping more generally is a key strategy for enhancing rural livelihoods (Gupta *et al.*, 2014). FAO's diversification tools underpin this approach by providing support for market analysis; development of equipment, standards, certification; marketing, products, packaging; and brokering relationships and trust through supply chains (Bradbear, 2009; Hilmi *et al.*, 2011). Participatory action research has demonstrated successful outcomes from strengthening beekeeping in rural livelihoods in Cameroon (Ingram and Njikeu, 2011). A Salvation Army program around Kavwaya in the lower Congo, initiated more than 20 years ago, has established low-cost beekeeping among rural communities, with significant financial returns — for example, one harvest from five hives returned the equivalent to local average annual wages. People have been able to pay school fees and medical expenses previously beyond their reach (Latham, 2009). Nevertheless, several recent studies have noted that there is significant unrealized potential for beekeeping as a sustainable livelihood in developing world contexts, and recommend strengthening of knowledge as well as technology as key to empowering its adoption (Ubeh *et al.*, 2011; Carroll and Kinsella, 2013; Kimaro *et al.*, 2013; Masuku, 2013; Ja'Afar-Furo, 2014).

Non-destructive honey hunting is also recognized as useful to pollinator protection and rural livelihoods (Joshi and Gurung, 2005). The Indonesia Forest Honey Network (JHMI), a network of producers, is assisting honey hunters to market their products with a premium for their sustainable practices (Césard and Heri, 2015). Support for local honey harvesters in the Bijagos Islands of Guinea Bissau has enabled them to adopt non-destructive practices that maintain rather than damage pollination resources **(Case example 5-25)**.

5.4.7 Management and mitigation options most relevant as integrated responses

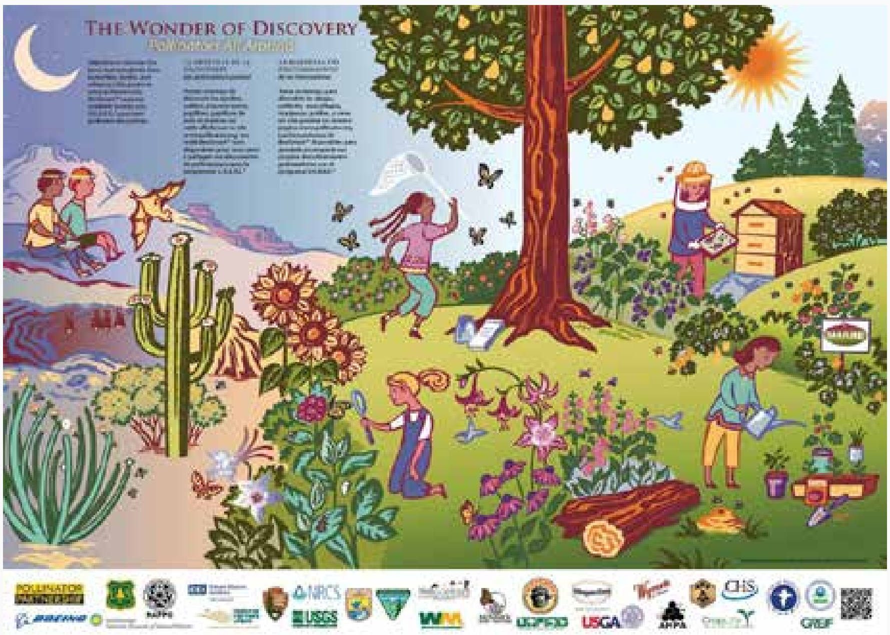
5.4.7.1 Values and frames approaches to conservation

"Values and frames approaches to conservation" encapsulated a range of new methods that focus on framing conservation to link with peoples' values. These new methods respond to evidence that societal concerns about pressing problems including global poverty, climate change and biodiversity loss, are relatively low compared to others such as terrorism, health care and the economy (Novacek, 2008). The response of concerned scientists has been to provide more and more factual evidence, based on a deficit model of communication that assumes this lack of concern is grounded in ignorance (Groffman *et al.*, 2010). However, human judgements are highly influenced by overall feelings and emotions, understood through metaphors, and how these connect to their most important values and frames (Lakoff and Johnson, 1980; Lakoff, 2004; Crompton, 2010). Values and frames approaches are therefore integrated responses to the key risk identified above that people's experiences of the causes of pollinator decline are mostly of multiple interacting threats that impact widely on their values.

Values and frames approaches are relatively new in pollination-specific context, although such organisations explicitly undertaking these approaches to promote conservation of biodiversity and ecosystem services generally are now established in 12 countries, including Australia, Sweden and Brazil. Examples in the pollination-specific context include the Faith Task Force that has produced publications on the linkages between several major religions and pollination (NAPPC Faith Task Force, 2012). Other initiatives are linking the art, literature, music and religious significance of bees and others to the scientific understanding of their roles in food production — enabling artists, writers and others to become involved in and supportive of impact management and mitigation. The Pollinator Pathway project, initiated by artist Sarah Bergman, is a good example of this type of approach, linking the values of art, design and ecology. The "Wonder of Discovery" **(Figure 5-26)** similarly links people's values with pollinators, showing engagement as bat and butterfly observers, monarch butterfly taggers, beekeepers, gardeners and through SHARE (Simply Have Areas Reserved for the Environment) (Vibbert, 2013).

FIGURE **5-26**

The "Wonder of Discovery" poster showing some socio-cultural values of pollinators (Vibbert, 2013). © Pollination Partnership. Reproduced with permission.



5.4.7.2 Rights-based approaches to conservation

Rights-based approaches are founded on respecting human rights institutions, and integrating human rights norms, standards, and principles in policy, planning, implementation, and evaluation to help ensure that conservation practice respects rights in all cases, and supports their further realization where possible. Rights-based approaches have much in common with biocultural and endogenous approaches, but greater emphasis is given to global and national human rights frameworks and standards (Campese *et al.*, 2009). The United Nations adopted a Statement on Common Understanding of on Human Rights-Based Approaches to Development Cooperation and Programming in 2003 (United Nations, 2003). For example, this statement includes recognition that people are key actors in their own development, and that development processes need to be locally owned, in common with principles for endogenous development.

In relation to nature conservation and integrated responses to risks for pollination and pollinators, rights-based approaches (RBA) in part respond to recognition that fortress conservation approaches have resulted in numerous human rights abuses, through eviction of people from their traditional lands without compensation or fair processes, and through disruption and denial of access to resources essential for their cultural practices and human well-being (Colchester, 2004). RBAs have been identified as capable of enabling actors to understand the situation of marginalized communities in a systemic manner and to address the underlying factors of vulnerability, poverty and powerlessness. They can also help attain long-term conservation while supporting local people to live in dignity (Oviedo and Puschkarsky, 2012).

RBAs can involve a range of different mechanisms, many of which are discussed above as part of biocultural approaches. Here we focus on three aspects particularly relevant to the drivers of risks to pollinators and pollination **(Table 5-4)**:

- Prior and Informed Consent for conservation, development and knowledge-exchange projects;
- Securing tenure over traditional lands;
- Strengthening governance over traditional lands.

5.4.7.2.1 Prior and Informed Consent over conservation and development projects and knowledge responses

The principle that indigenous peoples are able to give or withhold their 'free, prior and informed consent' (FPIC) to development and conservation projects that will affect them is recognised under international human rights law and as industry best practice for extractive industries, logging, forestry plantations, palm oil, protected areas and projects to reduce greenhouse gas (GHG) emissions from deforestation and forest degradation (Carino and Colchester 2010). Many of these are drivers of risks and opportunities for pollinators and pollination enabling RBA to have a positive effect (5.4.2). For example, the *Forest Rights Act* in India has secured access to forests by honey hunters, keeping alive their knowledge and practices for fostering honey and bees (Demps *et al.*, 2012b). Application of FPIC processes for protected creation in Australia enables identification of culturally-significant pollination-dependent fruit, their bird and bat pollinators and habitats requiring protection **(Case example 5-21)**.

In reviewing application of FPIC, however, Carino and Colchester (2010) found that relatively few national legal frameworks explicitly require respect for this right and World Bank standards have yet to be revised in line with these advances in international law. Connection is lacking between international law respecting the right to FPIC, and nation-states' laws about resource exploitation in the 'national interest'. FPIC is poorly implemented by corporations and government agencies, reducing it to a simplified check list of actions for outsiders to follow, again removing control over decisions from indigenous peoples (Wilson and Dialogue, 2009; Lehr and Smith, 2010; Minter *et al.*, 2012). Effective FPIC processes enable indigenous peoples' rights to represent themselves through their own institutions and make decisions according to procedures and rhythms of their choosing (Carino and Colchester, 2010).

Many potential knowledge responses to the risks and opportunities of pollination and pollinators are presented in Chapter 6. FPIC from indigenous peoples and local communities is particularly important in these responses. Legal arrangements underpinning research, for example, often transfer rights over the collected knowledge from the original knowledge holders to those who record it; prior agreements (utilising FPIC) are essential to protect ILK-holders' intellectual and cultural rights. International best practice guidelines for FPIC in knowledge responses include the Tkarihwaié:ri Code of Ethical Conduct (Convention on Biological Diversity, 2010) and the Code of Ethics of the International Society of Ethnobiology (International Society of Ethnobiology, 2006). The Guna General Congress found effective means of enforcing their intellectual property rights through negotiated agreements **(Case example 5-26)**.

5.4.7.2.2 Securing tenure over traditional lands

Beekeepers and honey hunters often do not have secure tenure under nation-state legal arrangements over the land and forests where their bees forage, and their traditional management systems are being eroded by the expansion of industrial agriculture (van Vliet *et al.*, 2012; Césard and

CASE EXAMPLE **5-26**

GUNA GOVERNANCE, INTELLECTUAL RIGHTS AND POLLINATORS

Location: Panama

Indigenous people: Guna; Atencio López oral account, p. 44-45 (López *et al.*, 2015)

Co-produced case example
Underpinned by direct interactions with indigenous and local knowledge-holders

"I summarise the Guna system of governance: Indigenous peoples speak of autonomy, which does not just mean the day to day administration, but also governance of resources. In February 2015, the Guna celebrated 90 years of autonomy. There are 2 systems of authority and control: 1) the communities (52 communities) make decisions on collective rights. There is no private property as it is understood in western culture; 2) the other authority is the caciques, the Guna General Congress is the political administrative organ, while the General Congress of Culture is the spiritual-religious organ, which has the priests. When it is related to natural resources, no project can be implemented in the communities without the approval of the General Congress. There are also projects that are proposed by the communities that the General Congress must approve. Within the Guna community, there is a [customary] law that the government does not officially recognize, but that is respected nevertheless."

Guna people used their governance, even though it is not government-recognised, to protect their intellectual property rights over the pollinator-dependent cacao fruit. The Congress imposed a fine on a business called CocoaWell for using Guna imagery, and negotiated an agreement that they must pay a percentage of their profit (López *et al.*, 2015).

Heri, 2015; Perez, 2015; Samorai Lengoisa, 2015). In November 2014, they argued a case in the African Court On Human and Peoples' Rights that Ogiek community's rights to life, property, natural resources, development, religion and culture were being infringed by persistent harassment and evictions from their ancestral lands in contravention of the international human rights standards of free, prior and informed consent (Samorai Lengoisa, 2015; Tiampati, 2015). A decision is due in 2015. Forests under common property and customary law systems have been shown to produce both livelihoods and biodiversity conservation, complementing biodiversity outcomes from protected areas (Persha *et al.*, 2010). Significant evidence that rights-based approaches work for conservation came from a study of 80 forest commons in 10 countries across Asia, Africa, and Latin America showing that larger forest size and greater rule-making autonomy at the local level are associated with livelihood benefits, and high carbon storage in trees, thereby protecting pollinator resources from the flowering of those trees and presumably also the pollinators (Chhatre and Agrawal, 2009). The authors argued that local communities restrict their consumption of forest products when they own forest commons, and that transfer of ownership to these communities would help support conservation. From this perspective, the global growth in indigenous and community reserves, territories and protected areas is likely to be making a positive contribution to the conservation of wild pollinator habitats (Berkes, 2009; Rights and Resources Initiative, 2014).

Nevertheless, the means of implementation of RBA have a critical influence on their effects. In Cambodia, simultaneous implementation of individual titles for farmers and communal title for indigenous communities has fractured forest commons management systems (Milne, 2013). Land titling in a national park in Cambodia led to a decrease in traditional practices that had maintained agro-biodiversity (Travers *et al.*, 2015). The *Forest Rights Act* in India, promoted as a means of recognizing rights of tribes and forest dwellers, while providing positive benefits to pollinators through support honey hunters as noted above, has also undermined some common property systems and imposed a new set of external agents engaged in defining their affiliations that have been detrimental to social and cultural values (Bose *et al.*, 2012; Kumar and Kerr, 2013). Two major lessons have emerged from these and other experiences in rights-recognition of tenure for conservation (Johnson and Forsyth, 2002). First, the nation-state's efforts to recognise rights are influenced by the broader public discourse and contest between commercial interests that opposed minority groups' rights to valuable resources, civil society interests that may negotiate rights-regimes within the wider public spheres in which rules, rights, and "community" are established, and defended (Johnson and Forsyth, 2002). Second, community-driven planning and capacity building are essential to support implementation of rights in ways that contribute to conservation of biodiversity and ecosystem services.

5.4.7.3 Knowledge co-production

ILK, in co-production with science, can be source of solutions for the present challenges confronting pollinators and pollination. Initiatives that are co-producing relevant knowledge range across classical science-driven investigations of the conditions under which diversified farming systems are underpinned by ILK protect of pollinators and pollination (Webb and Kabir, 2009; Perfecto *et al.*, 2014), through long-term science-ILK projects involving common research design and implementation (Wolff and Gomes, 2015), to projects focused on strengthening ILK through networks. **Table 5-5** summarizes the examples of knowledge of co-production presented in this sub-section.

Scientists and traditional beekeepers in Nepal worked together to identify the advantages and disadvantages of traditional and modern beehives, and to promote co-design that maximizes advantages of both (Joshi, 2000). Recovery of traditional knowledge in some communities of Andean countries in South America, and concerns about conservation of pollinators, is evident through different programmes of environmental education and conservation of biodiversity of ecosystems in which different members of the communities participate (Ferrufino and Aguilera, 2006; Meriggi *et al.*, 2008; Pérez and Salas, 2008; Chicchón, 2010; Gómez, 2012; Ferrufino, 2013; Perichon, 2013; Rosso-Londoño, 2013). Although no mention is given directly and specifically to pollinators and pollination, the importance of keeping healthy environments to keep food diversity and to respect nature is emphasized.

Co-production between science and traditional ecological knowledge in the Western Ghats of India was found to fill gaps in both regarding the ecology of mistletoe infections adversely affecting harvests of amla (*Phyllanthus emblica* and *P. indofischeri*), an important source of local income (Rist *et al.*, 2010). Kayapo people and entomologists working together in 1977-78 collected stingless bees that included 56 species recognized by the Kayapo; the entomologists identified 66 species, of which 11 were unknown or not yet described in science, thus adding to the knowledge of both ILK and science (Posey, 1983b, a). Community ethnoentomological collections are proving an effective means of empowering traditional knowledge of insects, including of how to foster pollinators, and building synergies with science in both indigenous and local communities (Aldasoro, 2003; Aldasoro and Argueto, 2013).

Participatory evaluation of pollinator-friendly farming practices in local communities has been developed by the FAO into an effective framework for co-producing knowledge between scientists and farmers for ecological intensification of farming to support improved livelihoods (Grieg-Gran and Gemmill-Herren, 2012). Knowledge co-production is critical for sustainable and ecological intensification of food production in diverse small-holder farming systems, as this type of development is knowledge-intensive (FAO, 2014b).

TABLE **5-5**
Knowledge co-production examples presented here and their contributions to responding to risks and opportunities associated with pollinators and pollination

Knowledge co-production activity	Knowledge contribution to responses to risks and opportunities associated with pollinators and pollination (chapter 5 and chapter 6)
Investigating advantages and disadvantages of traditional and modern beehives	Pollinator management and beekeeping: maximising hive design for healthy bees
Environmental education that involves recovery of traditional knowledge	Monitoring and evaluating pollinators: learning about healthy environments and respect for nature
TEK-science about the ecology of mistletoe infections leading to decline harvests of amla fruit	Habitat management: relevant to increasing health of important pollination resource (amla flowers) for bird pollinators
Community ethnoentomological collections in partnerships with scientists	Pollinator management and beekeeping; monitoring and evaluating pollinators: identifying insects that are new to both science and ILK, empowering traditional knowledge of fostering pollinators
Participatory evaluation of pollinator-friendly farming practices	Diversified farming systems: replacement of traditional shade coffee plantations with sun coffee leading to large declines in migratory bird pollinators
Sharing of traditional and agro-ecological knowledge through networks of peasant farmers	Food sovereignty and ecological intensification and diversify farming systems: promoting pollinator-friendly farming
Indonesian Forest Honey Network	Livelihoods and beekeeping; pollinator management and beekeeping: improving economic returns from forest honey as an incentive to protect forests
Environmental impact assessments incorporating ILK	Pesticides, pollutants and GMOs; landscape planning: pesticides taken up into medicinal plants
Beekeepers and scientists coproducing knowledge about the risks posed by neonicotinoids to bees	Pesticides: Moratorium on use of neonicotinoids based on precautionary approach in favour of pollinator protection
Indigenous peoples and local communities engagement in environmental monitoring partnerships	Monitoring and evaluating pollinators: providing baselines for analysis of future trends
Community indicators	Monitoring and evaluating pollinators: baselines for analysis of trends in biocultural diversity
Two-voices story telling about ethnobiology of bees	Biocultural conservation; monitoring and evaluating pollinators; livelihoods and beekeeping
Promoting monarch butterfly as a boundary object, bringing in multiple knowledge	Integrated social and behavioural response; Values and frames approach to conservation

Knowledge co-production among ILK communities is proving effective in recovery of stingless beekeeping in Brazil (Jaffe *et al.*, 2015). Horizontal networks that join together interdependent producers to share traditional and agro-ecological knowledge, cultivate alternate circuits of exchange, and build urban-rural partnerships, are reshaping the horizons of possibility both for peasant communities and for the broader agri-food system in Chile (Aguayo and Latta, 2015). The Indonesian Forest Honey Network (*Jaringan Madu Hutan Indonesia*, or JMHI) is bringing forest honey harvesters together to exchange expertise in order to offer honey harvested in a sustainable way (for the bees); their honey was the first forest honey in Indonesia to get organic certification, which leads to much better income potential (Césard and Heri, 2015).

Knowledge co-production is vital in environmental impact assessments (EIAs) (Athayde, 2015). Tūhoe Tuawhenuaare in New Zealand through co-production with science have identified that the pesticide '1080' is taken up into their medicinal plants, with unknown effects (Doherty and Tumarae-Teka, 2015). In several Amazonian communities, the role of the indigenous environmental monitors or environmental agent has been increasingly recognized and supported through specific projects that attempt to integrate indigenous, academic and technical knowledge for biodiversity management and conservation (Athayde, 2015). Support for community indicators is emerging as an effective means of knowledge co-production to monitor trends in biocultural diversity (Verschuuren *et al.*, 2014).

Co-production of knowledge between beekeepers and scientists in France and the European Union about the risks posed by neonicotinoids to bees has led to the adoption of moratoriums on their use, reflecting a false-positive evidence-based policy, that prefers to bear the costs of being wrong about the harm posed by these chemicals, rather than overlooking that harm (Suryanarayanan and Kleinman, 2014; Suryanarayanan, 2015). The processes of co-production were complex, involving government regulations to restrict pesticide usage, legal action, protests, compilation of evidence by beekeeper organisations, and consideration by an expert committee of scientists who identified risks that were in agreement with field observations of several beekeepers, stimulating additional research (Suryanarayanan and Kleinman, 2014). The co-produced knowledge thus formed part of collective action by farmers, environmentalists and public actors that shifted policy towards a precautionary approach in favour of pollinator protection (Suryanarayanan and Kleinman, 2014). In the United States, while beekeepers have been very active in compiling and communicating their knowledge of pesticide impacts, this on-the-ground evidence has been dismissed as anecdotal by the Environmental Protection Agency (EPA), who adopt a false-negative evidence-based policy, and will not restrict neonicotinoid use until a definitive role for neonicotinoids in causing bee harm has been proven (Suryanarayanan and Kleinman, 2011, 2013, 2014).

Emerging models for effective co-production between science and ILK emphasize building respect, trust, co-capacity and authentic relationships throughout the entire research process, from conception, through design, implementation and dissemination (Huntington *et al.*, 2011; Adams *et al.*, 2014). Two-voices story-telling between a scientist who moved towards understanding ILK and an indigenous person who took up studying science, reveals how their mutual interest in ethnobiology of bees allowed

FIGURE **5-27**

Youth Summit for Biodiversity and Community Action participants co-producing a poster about pollination.
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connections and co-production of knowledge about "bee-cultural" diversity (Rosso-Londoño and Estrada, 2015).

Knowledge co-production activities have highlighted the importance of boundary objects in communication across social groups. Boundary objects have the attributes of being plastic enough to adapt to local needs and the constraints of several parties employing them, yet robust enough to maintain a common identity across social groups. The objects may be concrete, such as a painting **(Figure 5-27)** or abstract (Star and Griesemer, 1989). The monarch butterfly is a key such boundary object for linking with diverse socio-cultural values of pollination in North America: its migration has reached an iconic status, becoming a symbol of nature; environmental health; safe migrations across national borders; spiritual metamorphosis and renewal; and the souls returning to Michoacán on the Day of the Dead. These meanings have yielded a powerful story line that connects the conservation and management of the monarch butterfly to the credibility, status, and trust enjoyed by a diverse range of actors (Gustafsson *et al.*, 2015).

5.4.7.4 Collaborative governance

Collaborative governance arrangements that support effort alignment, inclusion of local actors, scale-dependent responsibilities for all actor groups, nurturing mid-scale managers and scale-crossing brokers to link multiple actors in the network and support social learning have been identified as key to improving governance of pollinators and pollination in Sweden (Ernstson *et al.*, 2010). Collaborative governance or co-governance is a process that articulates the context, knowledge, process, and vision of governance, linking multiple stakeholders together, and thereby connecting with their multiple socio-cultural values. Landscape and continental-scale efforts at creating habitat corridors, recognized as important to a diverse suite of pollinators, particularly migratory birds, have highlighted the need, potential and challenges in co-productive governance (Perfecto *et al.*, 2014; Wyborn 2015). Rather than a tension between top-down and bottom-up processes, co-productive governance mobilizes institutions with scale-dependent comparative advantage for landscape-scale conservation (Hill *et al.*, 2015a). Collaborative governance supports cross-node, cross-level linkages in polycentric systems (Brondizio *et al.*, 2009).

In managing and mitigating impacts from pollinator decline, collaborative governance approaches offer the advantages of forging linkages across sectors (e.g., agriculture and nature conservation), across jurisdictions (e.g., private, government, not-for-profit) and among levels (e.g., local, provincial and national governments. This linkage capability overcomes many risks arising from the pollination governance deficits identified above (5.4.2.8), such as contested land use, numerous, fragmented multi-level administrative units that trigger under-valuing of pollination, marginalization of key actors oriented to protection of pollination, scale mis-matches, and networks that cross scales but do not span and low levels of flexibility for adaptation. Collaborative governance also addresses impediments such as delayed feedbacks and insufficient information flows that have recently been identified as barriers to delivery of the Aichi Targets under the Convention on Biological Diversity (Secretariat of the Convention on Biological Diversity, 2011; Hill *et al.*, 2015b).

A number of initiatives are now underway globally, for example, the Pollinator Partnership that links corporations, universities, local, regional and national governments and communities into their collaboration across the globe. While results from this initiative are difficult to discern, analysis in the EU context suggests that social norms, habits, and motivation are the key to effective governance outcomes (Ratamäki *et al.*, 2015). Maturation into broad social norms requires engagement of people into over long time periods, and involves several stages, including roles for social actors to challenge current practices, suggesting more time and engagement are needed for effective pollination governance to be leverage from these initiatives (Hill *et al.*, 2013).

5.5 METHODS

5.5.1 Review protocols

This review and analysis of the biocultural diversity and socio-cultural values associated with pollinators combined the strengths of systematic review (Collaboration for Environmental Evidence, 2013) with those of historical and social research methods aimed at sourcing the best and richest sources for the topic under investigation (Carr, 1961; Liamputtong, 2008). The review and analysis occurred through four main phases in the lead-up to the Second Order Draft:

- **Initial scoping literature review:** screening, selection and development of First Order Draft (FOD)
- **ILK scoping literature review:** screening, selection, review of FOD and provision of advice for the Second Order Draft (SOD)
- **ILK global and community dialogue:** selection of material from the proceedings (Lyver *et al.*, 2015)
- **Gap-filling literature review:** response to analytical framework for SOD, review comments on the FOD and advice from the ILK scoping review

5.5.2 Initial scoping literature review and development of FOD

Systematic searches of literature databases were conducted by geographic region for South America, North America, Europe, Asia, Africa and Oceania. Search terms focused on biocultural diversity, and pollinators and their social-cultural values for indigenous and local communities. Systematic searches for relevant literature were conducted for South America, North America, Europe, Asia, Africa and Oceania, including regionally-specific terms, such as "sugar-bag" in Australia. Spanish language searches were undertaken for South and Central America. Databases accessed included the Web of Science, York University Library Database, Science Direct and others **(Table 5-6)**. Additional sources were obtained by using forward and back citations of key articles, and by contacting authors of highly-relevant articles. Material was screened and selected according to relevance, meta- and multi-case analyses, and global and regional overviews. The First Order Draft (FOD) was organized according to geographic regions that guided the literature reviews.

5.5.3 ILK scoping literature review

UNESCO, as the Technical Support Unit for the IPBES Indigenous and Local Knowledge (ILK) Taskforce, issued a call for relevant resources related to ILK and pollinators, which formed the starting point of the ILK scoping review. Systematic searches of English, French and Spanish databases and grey literature were undertaken using a variety of terms including bees, apiculture, beekeeping, flies, butterflies, birds, bats and beetles **(Table 5-6)**. Categories in the Zero Order Draft also guided the search (e.g., drivers, declines). Additional sources were obtained through personal requests from experts identified during the review. Review of the FOD guided additional searches to fill gaps. Material was screened according to the inclusion of ILK, the depth of its treatment, for more recent studies and for evidence of inclusive research methods. An excel spreadsheet of material was provided as input to the Second Order Draft (SOD).

5.5.4 ILK global and community dialogue

The ILK Taskforce convened an ILK dialogue to ensure interactions with and input from living indigenous and local knowledge systems into the pollination assessment (Lyver *et al.* 2015). Participants were selected from a global call for the global dialogue and subsequent community workshops. Members of the Taskforce also contacted specialist networks, such as the French National Museum of Natural History, to mobilize other expertise for the literature compilation and the workshop. ILK-holders from Africa, Asia, New Zealand and central America participated. Their contributions to this chapter are highlighted as 'Co-produced case example: underpinned by direct interactions with indigenous and local knowledge-holders'.

5.5.5 Gap-filling literature review

The gap-filling literature review was commenced by the development of an analytical framework for the chapter drawing on Berkes (2012) and input from ILK experts and knowledge-holders in attendance at the second author meeting held to consider review comments on the First Order Draft (FOD). Material arranged geographically for the FOD was reorganized according to these categories, which now form the sections and sub-sections of the chapter. Some material from the FOD was removed as not relevant to the analytical framework or in response to the review comments. Additional categories were generated through consideration of the advice from the ILK scoping review, and the review comments on Chapter 5. The gap-filling literature review concentrated on Web of Science, Google scholar and Google books **(Table 5-6)**. We also examined international lists of heritage values, which adds rigor to understanding values (Tengberg *et al.*, 2012). Material was prioritized according to relevance, evidence of inclusive processes with ILK holders, peer review, meta-analyses and multiple case studies. While our review highlighted a range of values, few studies had explicitly focused on eliciting values of pollinators and pollination through socio-cultural or holistic methods. An opportunity exists to strengthen

TABLE **5-6**
Examples of data bases and search terms in each phase of the review and analysis

Phase	Examples of data bases and other literature	Examples of search terms
Initial scoping literature review	Web of Science, Google scholar, Springerlink, Cambridge journals, Google, Science direct	Traditional bee keeping, local community knowledge and wisdom, pollination
ILK scoping literature review	Scopus, Research Gate, SciELO, Instituto Socioambiental (http://www.socioambiental.org/pt-br); UN reports, books	TEK, ILK, ecological, knowledge; apicultura, meliponicultura, escarabajos, savoirs locaux, savoirs traditionnels, savoirs autochtones
ILK global and community dialogue	Key experts and ILK holders identified through the global call and selection	During dialogue themes chosen were change, diversity, multiple values and knowledge protection
Gap filling literature review	Web of Science, Google scholar, Google Books, World Heritage List, Intangible Cultural Heritage list	Diversified farming, milpa, food and pollinators, heritage, symbolic values, innovations, wax in musical instruments

our understanding of the values of pollinators through application of these methods; policy-relevant knowledge would be strengthened by filling this gap.

5.6 CONCLUSIONS

The chapter provides the major response within the context of the pollination assessment to the IPBES goal to: *Recognize and respect the contribution of indigenous and local knowledge to the conservation and sustainable use of biodiversity and ecosystems.* UNEP/IPBES.MI/2/9, Appendix 1, para. 2 (d). The constraints of time and capacity have enabled us to interact with only a very few of the numerous indigenous and local peoples globally, to whom the global human population owes so much for their ongoing contributions to biodiversity and ecosystem services that sustain us all in forms such as clean air, sparkling waters and birds that nest and migrate across the globe. We have reduced to 'categories' the rich stories of these peoples that intertwine with living beings and spirits and are acutely aware of the flaws in this attempt to give a voice to ILK.

Tororo konch logog: god give us a generation of children

Konech komeg: give us honey

Konech konyegap ongweg: give us eyes to see the valleys in the forest

Rpewech mosotig, poponik, murguywet: protect our trees (mosotig, poponik…)

Ripwech moingonigochog po mogonjog: protect our hives of hardwood cedar

Konech keldop kugo nimokinochiy: give us the footstep of our forefathers that had success

Tororo rip kotop ogiot: god protect the house of ogiot

Tororo tomoyon KOTOP SOGOT: god bless our house of leaves

Sere! Sere! Sere! Sere!: Let it be well! Let it be well! Let it be well!

[the word sere depicts overall goodness]

We opened the chapter with some of a story of the Guna people who kindly hosted the ILK-science dialogue for this assessment. The power of stories to communicate between the technical aspects of science and the broader life-worlds of people is gaining greater recognition in academe (Groffman *et al.* 2010); we therefore shall also close the chapter with another story from that dialogue, this one part of a poem that we think captures most what we all collectively seek from the pollination assessment.

Lines from an Ogiek prayer sung while walking in the forest on honey-hunting (Samorai Lengoisa 2015).

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