CHAPTER 1

Economic Development and Conservation of Biodiversity: Understanding the Interface of Ape Conservation and Industrial Agriculture

Introduction

Tropical ecosystems sustain much of the earth's biodiversity, provide countless natural products and services—both locally and globally—and play critical roles in the regulation of the climate and the carbon and hydrological cycles. The expansion of agriculture into tropical forest ecosystems will therefore have enormous impacts on factors such as human and animal health (Karesh *et al.*, 2012), energy options and prices, biodiversity conservation and infrastructure (see Box 1.1). In addition, this expansion might drive, or be affected by, conflict in areas of resource scarcity. These factors all directly affect human survival and that of countless other species. The rapid expansion of agriculture is the main driver

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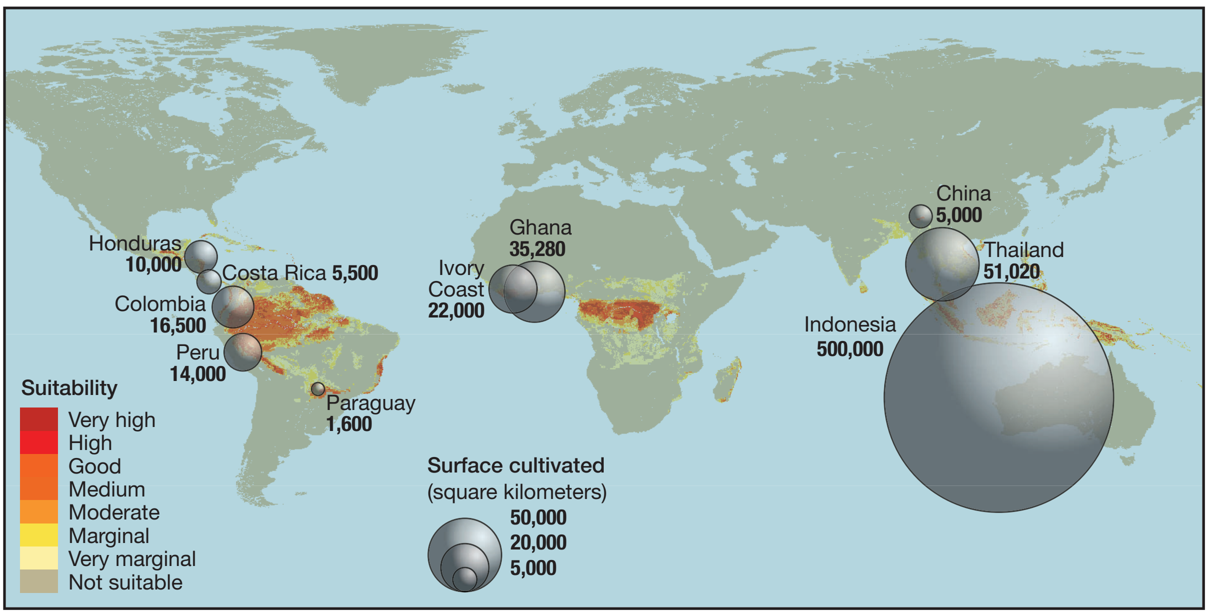
of tropical forest loss (Sodhi *et al.*, 2010). In much of the world, such expansion is led by large-scale, industrial agriculture, although small-scale agriculture also has a significant impact in some countries, particularly those in Africa.

Over the past 50 years, agricultural expansion has primarily been related to the foods and oils that form the basic diet for most of the world's human population: cassava, corn, palm oil, plantain, potato, rice, sorghum, soybean, sugar, sweet potato, wheat and yam. Many other crops, including cacao, coffee, peanuts, rubber, tea and tobacco, as well as various fruit crops, are also grown on industrial plantations. The main vegetable oils produced for global consumption include those made from coconut, cotton, oil palm, peanut, rapeseed, soybean and sunflower (Boyfield, 2013). Only palm oil and coconut oil are exclusively grown in the tropics. Palm oil accounts for 40% of the vegetable oil produced worldwide (Boyfield, 2013; USDA, 2014b).

Tropical forests in Africa and Latin America are the main frontiers for the future development of industrial agricultural plantations, particularly for oil palm. There is agreement within the agricultural development sector that the Amazon and Congo basins hold enormous potential for the creation of large-scale oil palm plantations, with 290,000 km² (29 million ha) of land suitable for oil palm cultivation in the Amazon alone (Corley and Tinker, 2003; Embrapa, 2010, cited in UNEP, 2011). The Institute for Economic Affairs estimates that 2.5–3.0 million km² (250–300 million ha) of land is suitable for food crops in sub-Saharan Africa, where only 1.8 million km² (183 million ha) is currently under cultivation (Boyfield, 2013). As Figure 1.1 shows, all the geographic areas most suitable for new oil palm development are in the tropics (UNEP, 2011). To a large extent, these areas also boast the greatest species diversity and abundance. Yet, due to the relatively high costs of labor and complex social and economic

FIGURE 1.1

Surface Cultivated and Model of Suitability for Oil Palm Plantations



Data sources: Model of suitability for oil palm plantations from IIASA (2002) and FAO (2002). Surface of oil palm cultivated from FAO (2009a)

Source: UNEP (2011)

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factors in Brazil and other parts of the neotropics, the palm oil industry is not as likely to see a huge expansion in this region as it is to focus on sub-Saharan Africa.

One means to protect intact tropical moist forests and biodiversity from conversion to agricultural plantations is to cultivate low-carbon-density land (LCDL)—including degraded forests—in both the neotropics and afrotropics. This approach avoids the release of carbon from the conversion of intact tropical forests and protects biodiversity. Sustaining the projected 17–29% increase in the cultivation of the three main commodity crops—oil palm, sugarcane and natural rubber—will require an estimated additional 600,000–660,000 km^2 (60–66 million ha) of land in the tropical moist forest belt over the next 50 years (Dinerstein *et al.*, 2014).

Much has been studied and written about the history and processes of oil palm development—and about the impacts of the crop on the environment. Far less is known about the impact of other agricultural crops grown at industrial scale. It is clear, however, that industrial cultivation of any commodity that involves the conversion of forest to an agricultural landscape will reduce forest cover and human accessibility to forest resources, including wildlife (see Box 1.2). Given the availability of relevant data and the relatively broad scope of research on oil palm production—as well as the related threats posed to biodiversity—this chapter (and the whole volume) is weighted heavily toward this particular crop and its impacts on tropical moist forests. It also presents findings of research on other industrial agricultural commodities, particularly if these have an impact on ape populations and habitats.

This chapter presents an overview of some of the critical issues at the interface between apes and industrial agriculture. To that end, it is divided into four sections. The initial section assesses the relevance of industrial agriculture—and specifically oil palm and palm oil—to poverty reduction. The second section discusses the impact of industrial agriculture on climate change. The third section, which explores the impact of industrial agriculture on apes, features two case studies that illustrate how the development of industrial agriculture affects apes as a result of increased exposure to people and human activities. The final section addresses the potential motivation for the agricultural industry to engage in ape conservation strategies and to mitigate the loss of ape habitats—and the means to do so.

Key findings of the chapter include the following:

- Oil palm development is not always beneficial to poverty reduction; in fact, it often exacerbates poverty while also degrading the natural resource base on which human livelihoods depend.
- Although the destruction of natural forest to create industrial agricultural plantations involves replacing one vegetation type with another, it does produce net carbon emissions and is contributing to carbon levels in the atmosphere, thereby aggravating climate change.
- The expansion of industrial agriculture into areas inhabited by apes can have multiple repercussions, including the loss of habitat, the killing of apes and an increase in conflict between humans and apes through competition over land and resources.
- While research has identified some management options and practices that agricultural developers can implement to promote the protection of forest habitats and conservation of apes—such as the translocation of resident apes and the maintenance of forest patches and corridors—more studies are required to enhance understanding of the ecological and social impacts of this industry.

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BOX 1.1

The Global Roadmap Project

There is a growing need to enhance our general understanding of and our ability to measure and assess the direct and indirect impacts of industrial agriculture on forest ecosystems and ape populations. That is particularly the case with respect to infrastructure development, such as roads (see Figure 1.2). The International Energy Agency anticipates that 25 million km of new roads will be built by 2050—60% more than were built in 2010. Around 90% of these new roads will probably be built in developing countries, largely in tropical forests that sustain exceptional biodiversity and vital ecosystem services (Dulac, 2013). Research shows that roads that penetrate into forests or wilderness often cause significant environmental problems, including habitat loss and fragmentation, overhunting, wildfires and other environmental degradation, often with irreversible impacts on ecosystems and wildlife (Laurance *et al.*, 2001; Blake *et al.*, 2007; Adeney, Christensen and Pimm, 2009; Laurance, Goosem and Laurance, 2009; Laurance *et al.*, 2014a).

In many nations, efforts to plan and zone roads are seriously inadequate (Laporte *et al.*, 2007; Laurance, 2007; Laurance *et al.*, 2014a). Since there is no strategic global system for zoning roads, each road project must be assessed individually, with little information on its broader environmental context (Burgués Arrea *et al.*, 2014; Laurance *et al.*, 2014a).

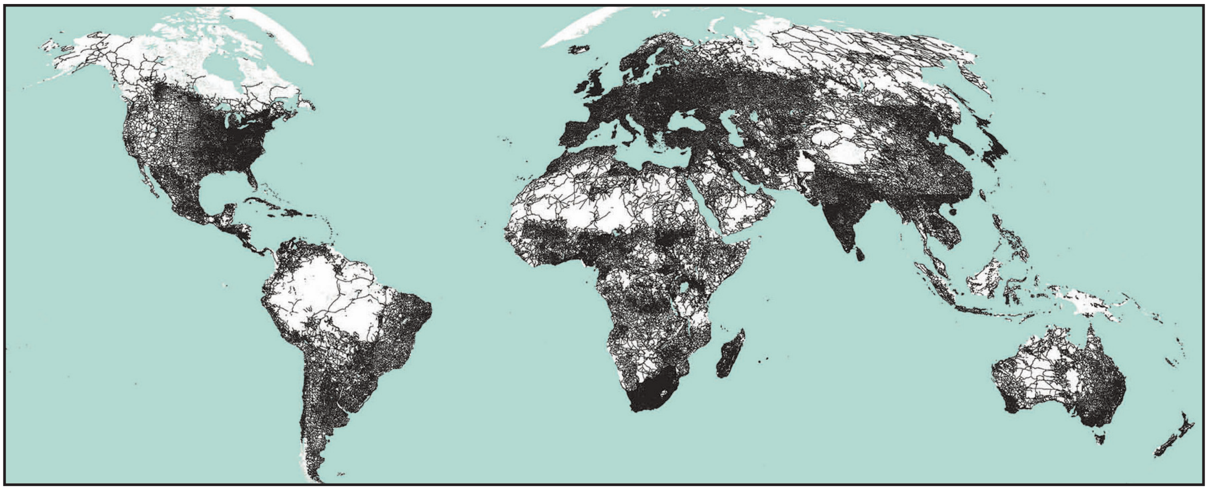
For these reasons, a group of environmental scientists, geographers, planners and agricultural specialists devised the Global Roadmap Project, a scheme for prioritizing road building around the world (Laurance and Balmford, 2013; Laurance *et al.*, 2014a; Global Roadmap, n.d.). This large-scale zoning plan seeks to limit the environmental costs of road expansion while maximizing its benefits for human development—especially for increasing agricultural production, an urgent priority given that global demand for agricultural commodities is expected to grow significantly in developing countries over the next few decades (Alexandratos and Bruinsma, 2012).

The Global Roadmap has identified three components—or layers—that are necessary to analyze the design and influence the approval of new roads and road improvements. The first is an environmental-values layer that estimates the natural importance of ecosystems; the second is a road-benefits layer that shows the potential for increased agricultural production, in part via new or improved roads. The third layer shows the distribution of terrestrial protected areas around the world. The Global Roadmap Project argues that protected areas should remain road-free wherever possible to limit the deleterious impacts that such roads often have on natural ecosystems.

Based on the combination of these three components, the Global Roadmap identifies areas of high environmental value, where future road building should be avoided; areas where strategic road improvements could promote agricultural development with relatively modest environmental costs; and "conflict areas," where road building could have sizeable benefits for agriculture but would cause serious environmental damage. The ultimate aim is for the Global Roadmap to be used by governments, stakeholders and environmental groups to help guide road planning. The plan provides a template for the active zoning and prioritizing of roads during the most explosive era of road expansion in human history.

FIGURE 1.2

Global Distribution of Major Roads



Note: Many illegal or unofficial roads are not mapped; see CIESIN and ITOS (2013).

Source: Laurance *et al.* (2014a, p. 230)

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BOX 1.2

Establishing an Industrial Agricultural Estate: Key Phases

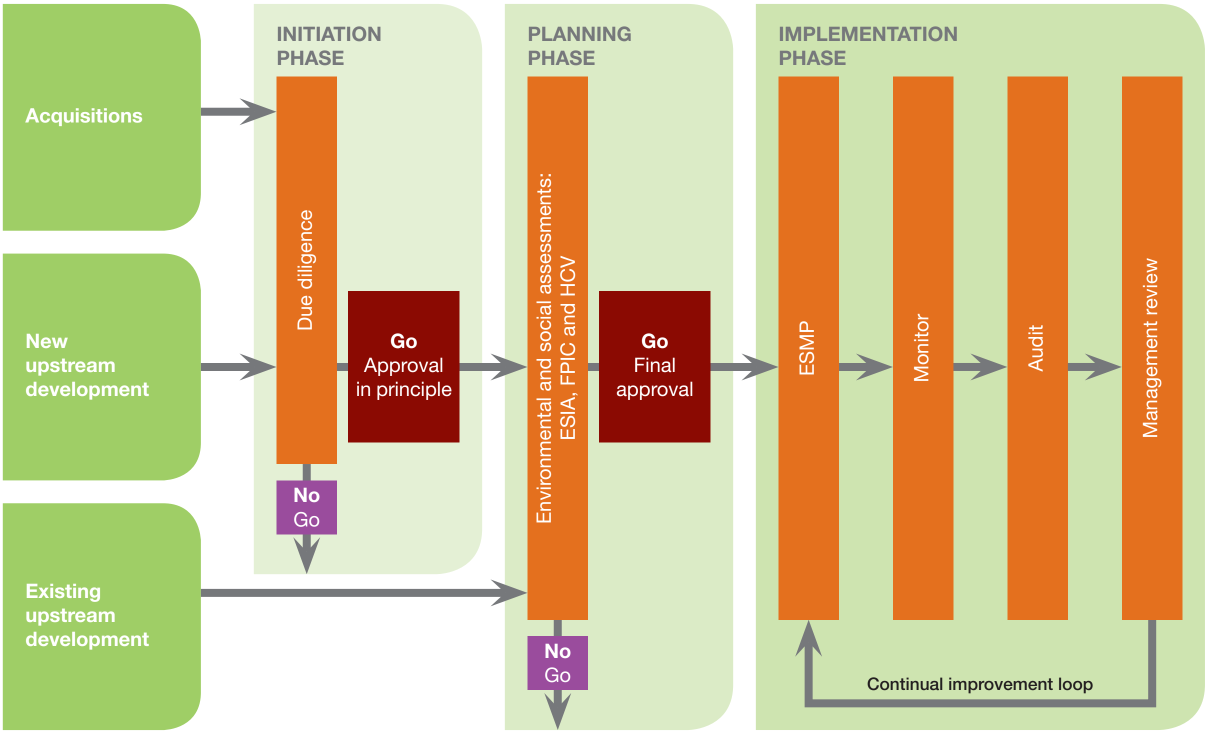
The establishment of a plantation project entails three stages of development: initiation, planning and implementation (see Figure 1.3). The phases are generally consistent across a range of crops, despite differing terminology used in the various agricultural sectors (Stewart, 2014). These three phases result in the identification of all potential environmental and social impacts of the project and the development of improved practices and mitigating measures relating to various physio-chemical, biological, environmental and social aspects (Corley and Tinker, 2003).

In Malaysia, it is now a legal requirement to carry out formal environmental impact assessments (EIAs) for each new development, in conjunction with the land evaluation process. In general, an EIA sets out baseline data on the geology and soil, water courses and quality, fauna, medical and health services, and other factors. The EIA is followed by an environmental management plan (EMP), which is used as a guide during the development of the agricultural estate, and which sets out the monitoring indicators to determine environmental impacts. This process provides guidelines that highlight the importance of preserving forest fragments and wildlife corridors to maintain biodiversity and wildlife in plantations (Corley and Tinker, 2003). Together with regulations designed to protect the environment and biodiversity in and around plantations, such as maintaining bands of riparian forest along watercourses, these formal requirements could provide an important legal basis for improved sustainability and environmental management. In many countries, however, these guidelines and regulations are frequently ignored, even if they are legal requirements, often due to corruption.

Avoiding and mitigating environmental damage in the early planning stages is far preferable to addressing it later, as it is more difficult and expensive to correct any faults if these are embedded in the plantation layout (Corley and Tinker, 2003). Appropriate actions range from the inclusion of analogous forests with multiple values that can support wildlife, to addressing landscape ecosystems that include plantations as a portion of the broader landscape, together with wildlife habitat, to form a stable system.

FIGURE 1.3

Development Stages of a Plantation Project



Notes: ESIA: environmental and social impact assessment; ESMP: environmental and social management plan; FPIC: free prior informed consent; HCV: high conservation value.

Source: Stewart (2014)

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Photo: The claim that palm oil production contributes to poverty alleviation in the tropics is controversial. © Patrice Levang

The Role of Palm Oil in Poverty Alleviation and Land Tenure

Palm oil is the most traded and affordable cooking oil in the world, with a higher yield per hectare than any other major oil crop. It is also used in numerous other products, from foods to biofuel, to toiletries and cosmetics. Oil palm occupies a relatively low percentage (7%) of land cultivated for vegetable oils (Caliman, 2011)—as compared to the much higher proportions of land allotted to soybean (61%), rapeseed (18%) and sunflower (14%); nevertheless, oil palm accounts for 40% of the global production of vegetable oil. Furthermore, its production costs are 20% lower than those of soybean, making it the cheapest of all vegetable oils to produce (Rival and Levang, 2014). As a result, palm oil production is widely thought to contribute to poverty alleviation in the tropics. This claim, however, is controversial (Budidarsono, Rahmanulloh and Sofiyuddin, 2012).

While palm oil production has certainly contributed to government revenue and corporate profit, even boosting the income levels in rural communities in many cases, an audit conducted by the Compliance Advisor Ombudsman for the World Bank in 2009 demonstrates that investment in the palm oil sector may actually have increased poverty in some places (CAO, 2009; Gingold, 2011). The problem does not lie with palm oil production per se, but rather with the governmental and industry processes and structures relating to land acquisition and loans for plantation development, and whether poor rural communities have been able to participate equitably in these. In Malaysia and Indonesia, for example, more than 40% of the surface area of plantations is owned by smallholders. When properly planned, in line with regulations that promote equitable development, oil palm plantations can lead to a decline in rural poverty and improvements in economic development in the regions concerned. Yet given corruption, poor planning or inequitable sharing of benefits, oil palm plantations can have an adverse impact on local populations (Rival and Levang, 2014).

While the World Bank study led to a moratorium on lending to the oil palm sector for two years, the debate over a causal link between the industry and poverty remains unresolved. The labor intensity of oil palm cultivation contributes significantly to employment in many regions, and additional benefits can include higher incomes and access to healthcare and education (Dayang Norwana *et al.*, 2011). A recent assessment of the local impacts of oil palm expansion in Malaysia shows that oil palm smallholders, who have benefited from higher returns than producers of other agricultural products, exhibit the lowest incidence of poverty across all agricultural sub-sectors (Dayang Norwana *et al.*, 2011).

Likewise, a recent assessment of returns to labor showed that oil palm can provide incomes two to seven times higher than the average agricultural wage (Budidarsono *et al.*, 2012), supporting a rural middle class over several generations—something few tropical crops can achieve (Rival and Levang, 2014). In Sumatra, Indonesia, for example, the annual income per hectare over the full cycle of a plantation averages €2,100 (US$2,675) for oil palm, €2,600 (US$3,312) for a clonal rubber plantation and €1,300 (US$1,656) for a rubber agroforest, compared to only €200 (US$255) for a rice field. A comparison of the return on labor is even more striking: €36 (US$46) per day per person for oil palm, €17 (US$22) for clonal rubber and €21 (US$27) for rubber agroforest—vs. €1.70 (US$2.17) per day per person for irrigated rice (Feintrenie, Chong and Levang, 2010, p. 12).[1] It is important to note that these figures refer to smallholders rather than to workers employed by large agribusinesses. A recent economic analysis of palm oil production with respect to per capita income in Indonesia shows that

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increasing productivity, rather than enlarging the size of plantations, is a more effective means of boosting income and reducing poverty (Nur Rofiq, 2013).

Whether such land conversion always delivers on these claims is highly contested, however, and significant long-term impacts result from trading traditional livelihoods for short-term cash rewards. The ability to adopt oil palm cultivation as a sustainable livelihood strategy depends on the extent of community land loss; such shifts in livelihoods can bring about processes of inclusion and exclusion (Dayang Norwana *et al.*, 2011). Due in part to poor land tenure mapping in Indonesia, conflicts have emerged over both land and tenure. In these contexts, smallholders are often obliged to take out loans to establish plantations; they receive limited technical support and the allocated sites may be suboptimal and distant from the community (Sheil *et al.*, 2009).

It is crucial to recognize that poverty is not simply about having an income below a predefined level; it is about the deprivation of necessities that constitute a minimally acceptable standard of living (Blakely, Hales and Woodward, 2004). The structural causes of poverty are multifaceted, influenced by economic, social and political factors. If country- and project-specific agricultural strategies, including those related to palm oil production, are to contribute to poverty reduction, they must be guided by clear objectives and measured according to their long-term success (CAO, 2009; Gingold, 2011). Until this is done the linkage between industrial agriculture and poverty reduction is by no means guaranteed.

Industrial Agriculture and Climate Change

Industrial agriculture is the second-largest contributor of global greenhouse gas (GHG) emissions, after energy generation, and

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before transportation (Stern, 2007); as such, it is an enormously significant factor driving man-made climate change. Perhaps unsurprisingly, this status has led champions of industrial agriculture to present climate-related arguments in favor of its expansion. Based on the fact that all green plants capture carbon in photosynthesis, they frequently—and often erroneously—assert that crops sequester carbon just as natural vegetation does, thus contributing equally to global reductions in GHG emissions and helping to combat climate change. This claim serves as the basis of a commonly argued corollary that is not necessarily accurate either, namely that replacing one type of tree with another has no impact on climate change—that such replacements are carbon-neutral acts. Taking this approach one step further, the Malaysian government successfully lobbied for rubber plantations to be classified as "forest" by the Food and Agriculture Organization (FAO) (Clay, 2004, cited in WWF, n.d.). The inclusion of plantations in a country's "permanent forest estate" can conceal its actual area of natural, biodiverse forest, while allowing lobbyists to promote the plantations that replace them as important carbon sinks.

It should be noted that the claim that plantations absorb carbon from the atmosphere to the same degree as natural forests is erroneous. A plant sequesters carbon while it is standing; accordingly, trees—whether plantation or natural forest species—will sequester carbon longer than annual plants with shorter life spans, such as grasses. In comparison to tropical grassland, tree plantations have the capacity for greater carbon fixation in biomass and soil organic matter as well as a higher rate of absorption of carbon dioxide (CO_2) from the atmosphere; however, these rates are far below those of natural tropical forests on mineral and peat soils (Germer and Sauerborn, 2006).

When oil palm plantations replace grasslands, it is possible that carbon sequestration exceeds carbon loss and that the plantation thus acts as a net carbon sink (Brinkman, 2009). Yet this ratio depends on the amount of carbon in the soil, as the conversion can release significant amounts of carbon and other GHGs. While forest conversion to create oil palm monocultures causes a net release of about 650 mg of CO_2 equivalents per hectare, the emission from peat forest conversion is even higher, due to the release of CO_2 and nitrous oxide (N_2O) from drained peat (Germer and Sauerborn, 2006). The impact is even greater if the use of fertilizer and emissions from processing are factored in. A new oil palm plantation may grow faster and thus sequester carbon at a higher annual rate than a naturally regenerating forest, but over 20 years the oil palm plantation will store 50–90% less carbon than the original forest cover (Ywih *et al.*, 2009). In addition, plantations are destroyed and

Photo: Industrial agriculture is the second-largest contributor of global greenhouse gas emissions. Forest clearance near Odzala-Kokoua National Park, Republic of Congo. © Jabruson, 2015. All Rights Reserved. www.jabruson.photoshelter.com

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replaced approximately every 30 years, a process that releases significant amounts of GHGs into the atmosphere.

The production of N_2O from the use of nitrogen fertilizers, such as urea, is also among the destructive impacts of industrial agriculture. The global warming potential of N_2O is 300 times greater than that of CO_2 (Stern, 2007). It is estimated that the production and use of nitrogen fertilizer for crops accounts for more than one-third of the GHGs released from agricultural fields (Paustian *et al.*, 2006). In addition, large-scale deforestation, soil erosion and machine-intensive farming methods all contribute to the concentration of carbon and other GHGs in the atmosphere.

It is ironic that palm oil biodiesel, a low-carbon alternative to fossil fuel-based gasoline for vehicles, was once hailed as a solution to climate change. It now represents a small proportion of the uses of palm oil, approximately 74% of which is used for food (USDA, 2010). As stated above, research has revealed that oil palm development, which often involves the clearing of intact forest, can contribute more GHGs to the atmosphere than it helps to avoid. Nevertheless, the sector has been able to exploit ambiguities concerning the type of land converted and the corresponding carbon stocks to make certain claims about emissions.

In practice, however, turning a hectare's worth of palm oil into biodiesel saves only about 6 tons of fossil CO_2 emissions per year, meaning that it would take 80 to 150 years of production to offset the one-off emissions released due to the requisite conversion of forest (Pearce, 2007). If the forest is on peatland—as is the case in parts of Indonesia—the offset requirements are far higher, largely because peatlands are too wet to decompose and thus store vast quantities of carbon. The conversion of a single hectare of Indonesian peatland rainforest releases up to 6,000 tons of CO_2 (Pearce, 2007). The practice of draining and converting these forests is especially damaging for the climate, as these "carbon sinks" store more carbon per unit area than any other ecosystem in the world. Draining peatland also makes it very prone to fires, which release an enormous amount of GHGs into the atmosphere (Trumper *et al.*, 2009).

Some claims and figures regarding emissions will remain disputed, but it is certain that monoculture plantations cannot match the carbon storage properties of natural forests and should not be promoted as though they can. It would be better for plantations to be cultivated on degraded lands, so as to avoid the destruction of natural forests. Some alternative initiatives—such as REDD+ (see Box 1.3)—provide opportunities to derive economic benefit from the sustainable management of natural forest estates, thereby helping to mitigate climate change.

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BOX 1.3

REDD+ as a Tool for Countering Forest Conversion for Agricultural Use

Deforestation and forest degradation account for nearly 20% of global greenhouse gas emissions (UN-REDD, n.d.-b). These are released through agricultural expansion, conversion to pasture, logging, other extraction activities, infrastructure development, fires and other means. At the same time, standing forests provide incalculable ecological benefits to our economies—to the tune of many billions of dollars per year (Krieger, 2001). Nevertheless, the need to provide comparable, tangible financial alternatives to forest conversion has long been a stumbling block for those seeking to conserve biodiversity.

The UN's Reducing Emissions from Deforestation and Forest Degradation (REDD) initiative is an "incentive system" that attempts to calculate a financial value for carbon stored in forests and to motivate developing countries to limit emissions released though the destruction of forested lands. REDD+ goes beyond the single objective of conserving the carbon value in forests by including the goals of biodiversity conservation, sustainable forest management and the enhancement of forest carbon stocks.

Traditional integrated conservation and development projects have aimed to generate income tied to conservation, but the funds leveraged can rarely compete with the economic drivers of deforestation and forest degradation. REDD+ is one of the means proposed to help transform the economy from one that is based on uncontrolled consumption to one that is sustainable (UN-REDD, n.d.-a).

The REDD Programme is the United Nations' collaborative initiative in developing countries, bringing together the Food and Agriculture Organization (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). Other initiatives that engage in REDD+ activities include the World Bank's Forest Carbon Partnership Facility (FCPF), Norway's International Climate and Forest Initiative, the Global Environment Facility, Australia's International Forest Carbon Initiative and the Collaborative Partnership on Forests.

REDD+ projects are under way all over the world, including in ape range states. The government of the Democratic Republic of Congo (DRC), for example, is promoting land use planning and REDD+ as a strategy to reduce deforestation. In addition to joining both the FCPF and the UN-REDD initiative, the government is leading a unique partnership of smallholder cacao farmers, the cocoa producer ESCO, the World Wildlife Fund (WWF) and the Wildlife Conservation Society (WCS) to test market-based alternatives to the conversion of forest into cacao plantations (Makana *et al.*, 2014). The pilot site, Mambasa, is part of the Ituri–Epulu–Aru landscape, an important habitat for chimpanzees.

REDD+ may offer incentive-based models as an alternative to the conversion of forests for industrial agriculture; in practice, however, there are numerous challenges to the success of these initiatives. These include:

- **Market mechanisms:** As there has been no international agreement on REDD, associated project developers can only sell their carbon credits on the voluntary market. If demand is low, an oversupply of credits can result in low carbon prices. At the time of writing, in May 2015, carbon prices stood at US$5 per ton, down from a high of US$17 before the economic downturn of 2008 (World Bank, 2014).
- **Measuring carbon and monitoring compliance:** It is difficult to accurately measure the quantity of carbon stored in a forest—and, consequently, the amount of carbon emissions avoided by preserving that forest. Similarly, it is difficult to assess whether a country is really reducing deforestation. The UNFCCC requires countries to use forest reference emission levels and forest reference levels to assess their performance in implementing REDD+ activities and mitigating climate change.
- **Embezzlement and the equitable sharing of revenues:** Some countries that are rich in natural resources suffer from issues of poor governance, which complicate efforts to ensure that revenue gets to the communities that depend on the forests, rather than, for example, agribusiness companies or local politicians.

Some stakeholders have suggested the creation of advanced market commitments by REDD+ donor countries—by which donors pledge to buy a certain number of carbon credits—and the expansion of existing risk guarantee products to cover market price risk. Other proposals suggest generating investments in certain forest ecosystem benefits that are "bundled" in with carbon, such as water, tourism and non-timber products. This approach would reduce the economic dependence on the sale of carbon credits.

In the absence of a climate change agreement, and with more focus on cutting emissions than on curbing deforestation, many REDD+ projects have been slow to take off. Preliminary analyses indicate that most of these projects are initiated in contexts where sustainable forest management projects were already in place. Yet, while REDD+ is still in its infancy, it has the potential to provide economic alternatives to the business-as-usual scenario of forest conversion into agricultural land. In addition to strengthening existing sustainable forest management projects, REDD+ presents an opportunity for the conservation community to access high political levels within governments, which is not normally possible via more traditional approaches.

A detailed examination of forest ecological services and the initiatives that support them, such as REDD+, is beyond the scope of this edition of *State of the Apes*; a future edition will feature an in-depth analysis of this emerging field.

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BOX 1.4

Conservation Agriculture: A Weapon in the Fight against Forest Destruction

The issue of sustainable productivity has as much to do with crops as with the socioeconomics of the market. The concept of sustainable crop production intensification (SCPI) arises from the pressing need to increase food production to feed growing populations, especially in urban areas. While the Green Revolution, initiated in the 1940s, was able to double grain yields and reduce hunger, malnutrition and poverty, it often did so at the expense of natural ecosystems and the resource base on which sustainability depends (B.G. Sims, personal communication, 2015).

The SCPI paradigm, promoted by FAO, is designed to augment production in a given area of land while simultaneously ensuring the conservation of natural resources, reducing the environmental footprint of agriculture and improving the flow of ecosystem services from the rural sector (FAO, 2011). SCPI endeavors to assist farmers to move from low production on degraded soils to higher, more sustainable production on healthy and improving soils.

Conservation agriculture (CA) forms an integral part of SCPI as it provides the optimum environment for healthy root development in crops, maximizes natural soil fertility and eliminates erosion. It is based on the following three tenets, which, while being universally applicable, require adaptation to local conditions:

- **Minimum soil disturbance resulting from tillage:** Plowing and cultivation are eliminated.
- **Maintaining organic soil cover:** Soils are kept covered with crop residues and cover crops for as long as possible throughout the year; in this way, they are protected from raindrop energy and insolation.
- **Diversifying species:** Crop, cover crop and associated crop species should be as diverse as possible, so that crop rotations are maintained both for main and cover crops.

Worldwide adoption of CA currently stands at 1.25 million km² (125 million ha)—or 9% of arable land—and is increasing by about 70,000 km² (7 million ha) per year (Jat, Sahrawat and Kassam, 2013). The main drivers of its adoption are the control of soil and water erosion and drought mitigation, although reducing production costs is particularly attractive to individual farmers and agribusinesses.

In Tanzania and other ape range states, smallholder farmers who cannot afford to invest in costly agricultural machinery are increasingly opting to rent machines as the need arises (Kienzle, Ashburner and Sims, 2013). In Tanzania's Arumeru district, members of a farmer field school are CA practitioners and also offer mechanized CA services to neighboring farmers. CA farmers in nearby Karatu district have brought their land back to its original condition—the state it was in before it was plowed; and since less labor is required for land preparation and weed control, children can now attend school more regularly and women can devote more time to other activities, including vegetable gardening. In addition, the reduced use of herbicides means that net incomes have increased (Sims, 2011, pp. 13–14).

The CA-led improvement of ecosystem services—especially with respect to cleaner water, reduced runoff and sedimentation, and aquifer recharge—has helped to promote the adoption of CA among farmers around the world (FAO, 2011). The rate of take-up remains slow but could be accelerated through sound government policies that support farmers and favor environmentally sensitive crop production. In turn, CA could make a major contribution to the protection of biodiversity and wildlife, including apes and gibbons.

Photo: A member of a farmer field school in Arumeru district, Tanzania, providing contract CA services. © Brian Sims

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Impact of Industrial Agriculture on Ape Populations

Industrial agriculture affects ape populations in numerous ways, both directly and indirectly. The destruction of ape habitat for the expansion of the agricultural estate is one of the three principal threats to apes, together with hunting and disease. Indirect impacts result from the construction of roads for the development of agricultural lands and transport of goods, the erosion and contamination of waterways on which apes and other wildlife depend, and the influx of people who hunt and capture apes to supplement their incomes or kill animals who are perceived as threats to safety or to their crops. The frequency of human–wildlife interactions is increasing significantly as people enter more areas that are adjacent to or inside traditional ape territories and plant crops that are either palatable to wildlife or that are destroyed by wildlife as they move through land that is part of their range.

With the expansion of industrial agriculture, natural landscapes are being replaced with large monoculture plantations that are inhospitable to many species and inhibit animals from reaching the remaining patches of natural forest. The result is that wildlife becomes isolated in small fragments of forest, with insufficient food, shelter and access to other individuals to maintain the genetic diversity necessary for survival of the species. For more details on the impact of industrial agriculture on ape ecology, see Chapter 6.

Given that the oil palm is most productive in its first 20 years—with peak yields between 13 and 14 years—plantations are generally rotated (destroyed and replanted) at 25–30-year intervals (UNEP, 2011; Rival and Levang, 2014). The process of planting reduces freshwater and soil quality and, by destroying or degrading natural vegetation, adversely affects local human and wildlife populations that are dependent on natural resources. One of the most damaging effects of oil palm is the drainage of peat swamps for conversion to plantations, which, as indicated above, has significant impacts on GHG emissions. Estimates indicate that between 1990 and 2005, 55–60% of oil palm expansion in Malaysia and Indonesia resulted in the destruction of tropical forests (Koh and Wilcove, 2008a, 2008b; WWF, n.d.).

An area that presents extensive opportunities for development is the intensification of production on currently cultivated land, such as through the implementation of CA practices (see Box 1.4). This approach counteracts the need for continuous conversion of more land for oil palm cultivation. Significant variability exists in the yields of plantations, from 2 to 10 tons of oil per ha (Carrasco *et al.*, 2014). Yield intensification has great potential as it satisfies the goals of both growers and conservationists (Rival and Levang, 2014; B. Dahlen, personal communication, 2015); yet, improved yields may also lead to higher interest in oil palm cultivation and, consequently, an increase in the demand for land.

Case studies 1.1 and 1.2 provide an overview of some of the impacts on apes resulting from the expansion of agriculture and the influx of people into areas that are also used by apes, or that border on ape ranges.

It is clear that industrial expansion of oil palm, even by companies that seek to take a more sustainable approach, has a direct negative impact on orangutan populations in Borneo and Sumatra. By displacing so many wild orangutans, oil palm expansion drives up the number of orangutans in need of rescue and protection in orangutan centers. Since 75% of the known orangutans live outside of protected areas (Meijaard *et al.*, 2010; Wich *et al.*, 2012b), understanding if and how the species could be effectively accommodated in an agro-industrial landscape is crucial to the long-term survival of these apes.

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CASE STUDY 1.1

Human–Wildlife Interactions: Orangutan Rescues in Kalimantan, Indonesia

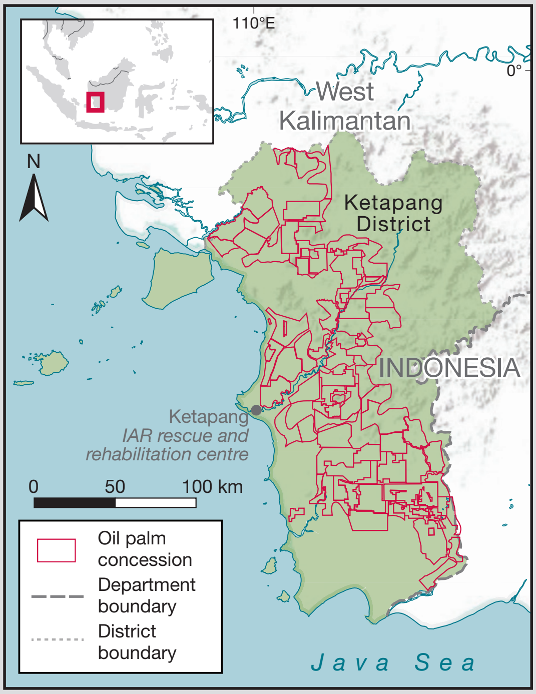
On the island of Borneo, in the Indonesian province of West Kalimantan alone, 326 oil palm concessions occupy 48,000 km² (4.8 million ha) of land—one-third of the total land area of 144,000 km² (14.4 million ha) (Hadinaryanto, 2014). In the southern part of the province, in Ketapang district—home to the Orangutan Rescue and Rehabilitation Centre of the International Animal Rescue (IAR)—there are nearly 100 concessions, all of which have significantly affected the natural forests (Sánchez, 2015; see Figures 1.4 and 1.5).

To address some of the challenges related to the capture of orangutans in plantations, the IAR Indonesia Foundation established the Orangutan Emergency Centre in 2009 and the Rescue and Rehabilitation Centre in 2013, with associated outreach activities. The aim of the foundation is to return captured orangutans to a life in the forest, thereby contributing to the species' survival in the wild. Rehabilitation and reintroduction programs provide a potential, albeit very expensive, solution to the problem of displaced or "refugee" orangutans living in rescue centers. They can also help to increase the viability of populations in areas where wild orangutans might be at risk of extinction or inbreeding; in some cases, they can even help to create new populations in areas where orangutans have been extirpated, provided the conditions that led to their extirpation are removed or addressed.

The IAR Indonesia Foundation reports that almost half (43%) of the 120 orangutans rescued between September 2009 and December 2014 came from villages where they were kept illegally by local people; 31% were rescued directly from oil palm plantations; 12% originated from local community agricultural landscapes (including rubber, rambutan, coconut and rice fields), often adjacent to oil palm plantations; 9% were transferred from other facilities; and 1% were recovered from the illegal wildlife trade (see Figure 1.6). Some of the orangutans that were rescued from captivity in villages might have

FIGURE 1.4

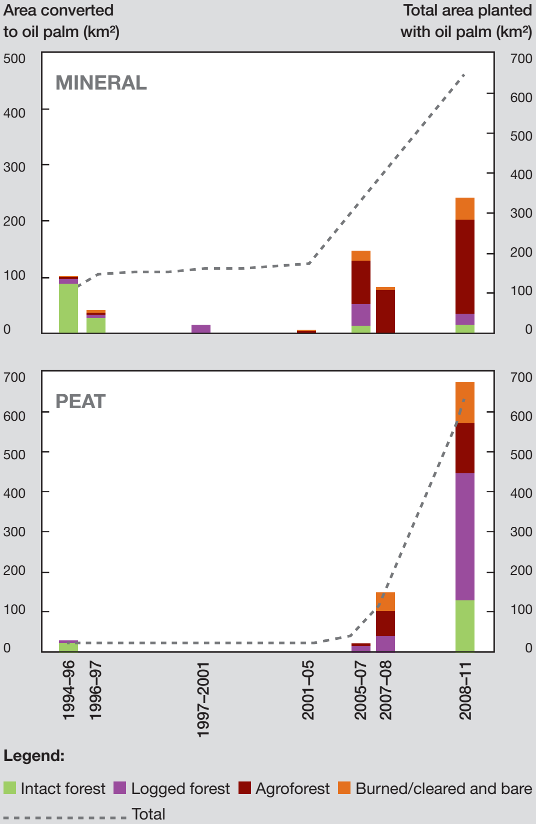
Map of Concessions in Ketapang District



Data sources: WRI (2014c, 2014e)

FIGURE 1.5

Land Cover Sources for Oil Palm Plantation Establishment and Total Planted Oil Palm on Mineral and Peat Soils in Ketapang District, 1994–2011



Source: Carlson *et al.* (2012, p. 7561)

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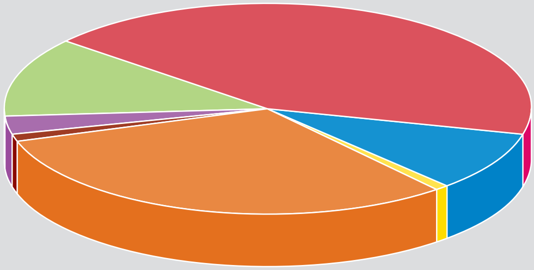
FIGURE 1.6

The origin of 120 Orangutans Rescued in Ketapang, September 2009–December 2014



Legend:

- Local community agricultural landscape (14 = 12%)
- Mining area/company (4 = 3%)
- Unknown (1 = 1%)
- Oil palm plantation (37 = 31%)
- Illegal wildlife trade (1 = 1%)
- Transferred from other facility (11 = 9%)
- Village (52 = 43%)

Courtesy of IAR

been originally captured as a result of conflict between orangutans and people in oil palm landscapes. Figure 1.7 shows the sites of IAR rescues in West Kalimantan and the Borneo Orangutan Survival Foundation (BOSF) rescues in Central Kalimantan, in relation to oil palm and wood fiber concessions.

In Ketapang, 13–25 orangutans have been rescued every year since 2009, with an annual average of 20 for that period. In Central Kalimantan the rescue rates have been higher; BOSF has reported an average of 67—or anywhere between 13 and 240—orangutans per year since 1999 (BOSF, personal communication, 2014). On the Indonesian island of Sumatra, the Sumatran Orangutan Conservation Project (SOCP) has rescued an annual average of 26 orangutans since 2002, recovering 9 to 37 individuals per year (I. Singleton, personal communication, 2014). All these areas have been subject to rapid expansion of industrial agriculture, a likely a factor in the high rates of rescue.

To promote better understanding of the drivers behind human–orangutan interactions, the IAR Indonesia Foundation categorized its findings as follows: the pet trade; conflict between orangutans and local agro-communities; and conflict between orangutans and oil palm plantations.

Pet trade. To capture baby orangutans, people involved in this illegal trade will either seize infants from their mothers or kill the mothers so as to capture the orphan. The captive apes are sold or kept as pets until they die or are handed over to the authorities. The hunting of orangutans for food (Meijaard *et al.*, 2011) may inadvertently be providing infants for the pet trade; IAR concludes that such captures most likely occur on an opportunistic basis.

Of the former owners or traders of captive orangutans rescued by the IAR Indonesia Foundation, 39% claimed to have "found" the baby or infant orangutan, while 29% admitted to having bought theirs. The remaining 32% of respondents did not wish to answer the question or the information obtained from them was unreliable (Sánchez, 2015).

The fact that none admitted to having killed the orangutan's mother may not adequately represent the extent of human involvement in the injury and death of orangutan mothers. As young orangutans rarely leave their mothers, it is likely that all the mothers were injured or killed before their offspring were taken. Captures may have occurred as a result of conflict, in the context of competition for food, as acquisitions for trade, or for other reasons. Owners who voluntarily handed over their orangutans reported that they had paid anywhere between 500,000 and 1.5 million Indonesian rupiah (US$50–150) for a baby orangutan. The fact that the infants were acquired locally suggests that they originated from a nearby location.

Conflict between orangutans and community agricultural landscapes (local agro-communities). The increased frequency with which people kill orangutans is thought to be a result of the intense deforestation and land clearance for agriculture, as people encroach into previously inaccessible forest and encounter orangutans more often. Furthermore, as the availability of natural foods decreases, orangutans increasingly enter villages, gardens and local plantations to crop raid or "pass through," leading to a higher incidence of conflict with people.

Conflict between humans and orangutans is not only driven by economic factors, but also driven by local perceptions and legends surrounding these animals (Campbell-Smith *et al.*, 2010). Local people are often afraid of orangutans, particularly if they are walking on the ground, which can lead people to harm or kill the apes.

A solid understanding of the perceptions of those who live in and around orangutan habitats, particularly areas where human–ape conflict is common, is key to the development of mitigation techniques that can effectively reduce the conflict and killings, and build trust in and encourage support for wildlife among local populations.

Conflict between orangutans and oil palm plantation owners and workers. The frequency of human–orangutan interactions tends to grow as oil palm plantations move through the successive stages of development. During the first stage of development, degraded forest or agricultural land is utilized, or natural forest is clear-cut or burned. If people encounter orangutans during land clearance, they generally kill the mothers so that their babies can be captured and used as household pets or sold; alternatively, they may kill all the orangutans they come across. During the seedling phase,

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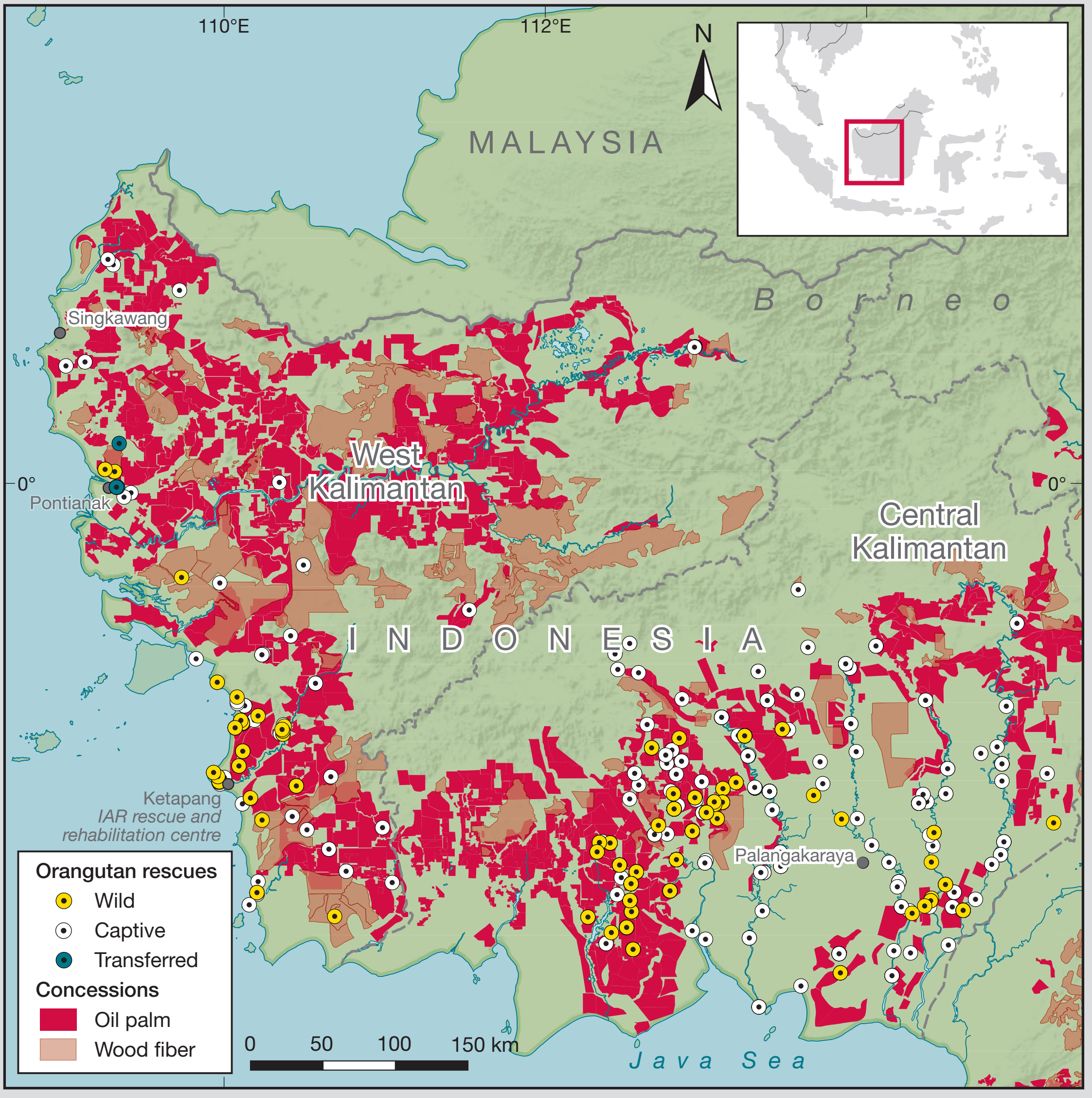
FIGURE 1.7

IAR and BOSF Orangutan Rescues in Relation to Agricultural Concessions



Data sources: rescue data: IAR and BOSF; data for base map: WRI (2014c, 2014e)

conflict occurs when orangutans pull out and eat the palm shoots. Orangutans are then seen as a pest and chased off, injured or killed.

When orangutan habitat is destroyed, the survival rate of female orangutans and their offspring is impacted directly by the reduction in their home range and subsequent starvation. Orangutan males fare marginally better as they are able to migrate to remaining forest areas (van Schaik, 2001; Wich *et al.*, 2012b). However, such migration may result in increased competition among individuals in the new area and overcrowding of habitats, which may exceed their carrying capacity (Wich *et al.*, 2012b); it may also heighten the risk of orangutans entering gardens, villages or other plantations, which can lead to further conflict (Meijaard *et al.*, 2011). For more information on the impacts of industrial agriculture on ape ecology, see Chapter 6.

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One mechanism that is used for managing biodiversity risk in extractive industries—and in other development projects—is the mitigation hierarchy (see Box 1.5). This planning tool is designed to help reduce negative impacts on biodiversity from extraction and exploitation of natural resources, and to identify compensation and mitigation measures in the absence of alternatives. However, the applicability of the mitigation hierarchy to industrial agriculture requires further investigation. Unlike the exploitation of mineral, oil and gas deposits, crop production is not tied to specific sites, so avoidance—a key step in the mitigation hierarchy—should be much easier. There is a growing understanding that the application of the mitigation hierarchy should be linked closely to multi-stakeholder, landscape-scale land use planning. That approach is especially important with respect to industrial-scale agriculture, as the siting of new projects may have a much greater negative impact on biodiversity than the establishment and management of a concession once its location has been decided. So while the principle of no net loss (or a net gain) of biodiversity might still be applied, there is a need to develop a new approach that combines the mitigation hierarchy with broad-scale and systematic land use planning (M. Hatchwell, personal communication, 2015).

BOX 1.5

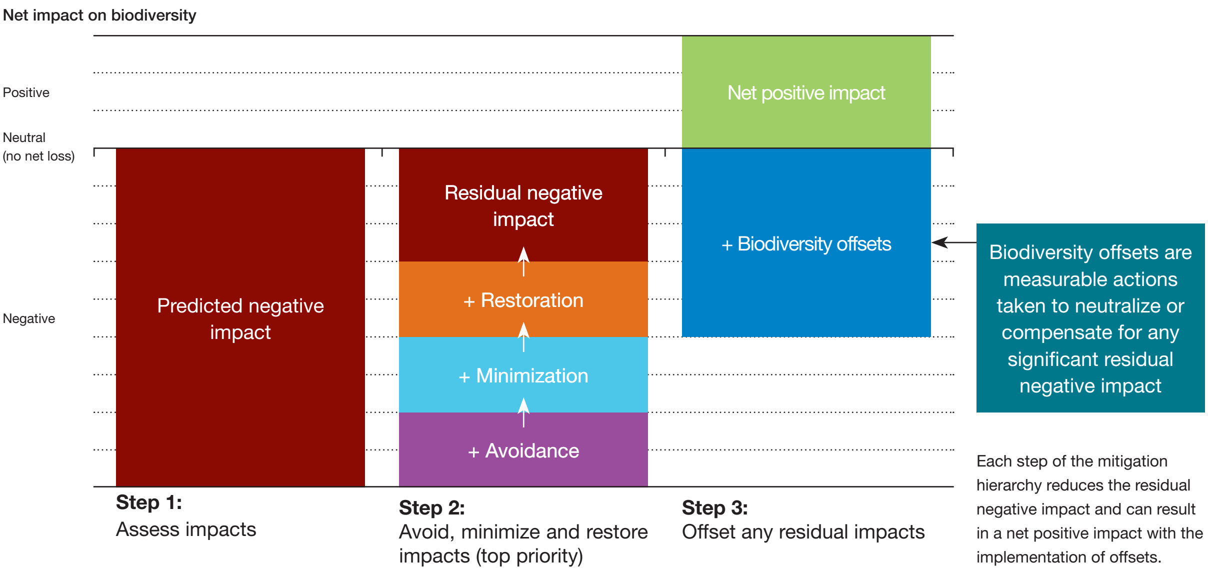
The Mitigation Hierarchy

The mitigation hierarchy is a best practice approach to managing biodiversity risk. It advocates applying efforts early in the development process to prevent or avoid adverse impacts to biodiversity wherever possible; then minimizing and reducing impacts that cannot be avoided; and then repairing or restoring impacts that cannot be avoided, minimized or reduced. Only once project developers have taken these initial actions do they respond to any remaining residual effects, preferably by creating a "biodiversity offset". If an offset is not possible, some other form of compensation may be needed (Arcus Foundation, 2014, pp. 144–5; see Figure 1.8).

FIGURE 1.8

The Mitigation Hierarchy and Biodiversity Impact

(developed by WCS for State of the Apes: Extractive Industries and Ape Conservation)



Source: Arcus Foundation (2014, p. 145)

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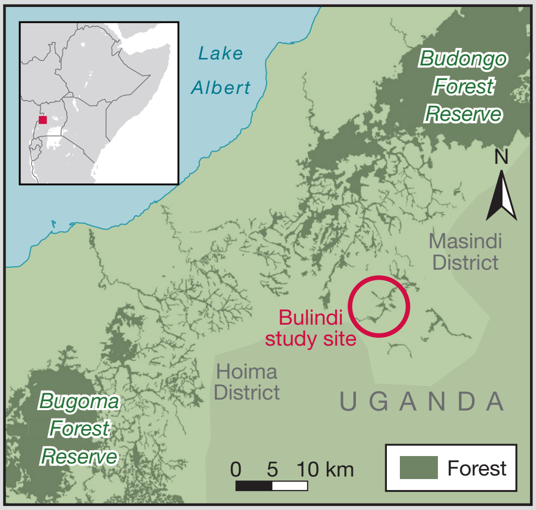
CASE STUDY 1.2

Changing Agricultural Practices and Human–Chimpanzee Interactions: Tobacco and Sugarcane Farming in and around Bulindi, Uganda

The Budongo and Bugoma Forest Reserves of western Uganda (Figure 1.9) support two of Uganda's largest populations of eastern chimpanzees (*Pan troglodytes schweinfurthii*), with more than 500 individuals in each group (Plumptre *et al.*, 2010). The two reserves are separated by 50 km of landscape that is densely populated by people and dominated by agriculture (McLennan, 2008). Nevertheless, the landscape has conservation value as a "corridor" linking chimpanzee and other wildlife populations in Budongo and Bugoma. Its corridor potential rests primarily on the network of small forest fragments that run alongside watercourses throughout the intervening area. These riparian fragments are mostly on local people's land and lack formal protection; they are inhabited by multiple groups—or communities—of wild chimpanzees who live outside the reserves, in close proximity to villages. These "village chimpanzees" may number as many as 260 individuals (McLennan, 2008). Conserving the corridor forests is critical to the survival of these chimpanzees and to maintaining gene flow between chimpanzee populations in the main Budongo and Bugoma forest blocks (McLennan and Plumptre, 2012).

FIGURE 1.9

Budongo and Bugoma Forest Reserves in Western Uganda and Small Riparian "Corridor" Forests in the Intervening Region



Notes: Most of these small riparian forests are on private land. The Bulindi study site is encircled.

Courtesy of Matthew R. McLennan

The best-known community of "village chimpanzees" is Bulindi's, studied since 2006 (McLennan and Hill, 2010). Bulindi parish, in Hoima district, lies 25 km south of Budongo and 40 km northeast of Bugoma, along the main road between Hoima and Masindi towns. Human population density in Hoima district is high, estimated at 159 persons per km² in 2014.[2] More than 90% of the district's residents live in rural areas and practice a combination of subsistence agriculture with cash cropping (UBOS, 2007). Like other communities in the Budongo–Bugoma corridor, the Bulindi chimpanzees range within a network of unprotected forest fragments on agricultural land. Local households own these small forests according to customary tenure, a common traditional system whereby clans control land and allocate plots to members; thereafter, the land is inherited patrilineally (Place and Otsuka, 2000). Few local households have formally registered land. Most villagers in Bulindi and elsewhere in Hoima district are native Banyoro who traditionally do not eat primates, enabling chimpanzees to persist in dwindling forest amid expanding agricultural systems (McLennan, 2008).

This case study considers how recent agricultural practices in Bulindi and the surrounding region—particularly the shift to commercial tobacco (*Nicotiana tabacum*) and sugarcane (*Saccharum officinarum*) farming—have driven rapid, extensive land use cover changes, meaning the conversion of unprotected forest to agricultural land. The resulting alterations in human–chimpanzee interactions are threatening the survival of the region's chimpanzees.

Recent Causes of Forest Loss

In Uganda, where most forest loss occurs on land that is not managed by the government, the deforestation rate is among the highest in Africa—2.6% in 2000–10, as compared to 1.0% in Cameroon, 0.7% in Liberia and -0.2% in the DRC for same period (MWLE, 2002; McLennan, 2008; FAO, 2011). Widespread clearance and fragmentation of unprotected forest within the Budongo–Bugoma corridor has recent origins, having gained momentum in the 1990s and continued to the present day (Mwavu and Witkowski, 2008; Babweteera *et al.*, 2011). Factors contributing to these land-cover changes are complex and should be viewed in the context of Uganda's Plan for Modernisation of Agriculture, part of the government's Poverty Eradication Action Policy, which focuses on the modernization and transformation of subsistence agriculture into commercial agriculture (MAAIF and MFPED, 2000).

As is well documented in the development literature, when farmers shift farming strategies to increase their income, or to adjust to declining income from existing cash crops, they generally increase the area under crops rather than adopting more intensive farming systems, inevitably putting natural habitat at risk (Bashaasha, Kraybill and Southgate, 2001; Pendleton and Howe, 2002). The rapid conversion of forest to farmland around Budongo and Bugoma has numerous causes, including the promotion of commercial farming alongside rapid human population growth—whether due to natural increase or immigration; a thriving local timber industry; insecure land tenure; inadequate law enforcement; and corruption at various

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administrative levels (Mwavu and Witkowski, 2008; McLennan and Hill, 2013).

Cash cropping combined with subsistence farming is not a new activity for local farmers. Commercial tobacco production began in Bulindi in 1927, promoted by the colonial administration as a lucrative alternative cash crop to cotton (Doyle, 2006). Back then, farmers cleared grasslands to grow tobacco, whereas now, the only land available to most farmers to clear is forested. In the 1960s, farmers in Bulindi, as elsewhere in Hoima district, planted cacao (*Theobroma cacao*) in riparian forest. Given that cacao grows best under shade, only the understory vegetation was cleared for plantations. The introduction of cacao marks the first reported appearance of conflict with resident chimpanzees, as they quickly learned to exploit the sweet-tasting pods (McLennan and Hill, 2012). Most plantations were abandoned in the 1970s and 1980s, following the breakdown in Uganda's cocoa industry (Kayobyo, Hakiza and Kucel, 2001). Unmaintained, the understory regenerated around the cacao trees, which continued to produce pods. As recently as 2012, cacao was among the main forest foods for chimpanzees in Bulindi (McLennan, 2013). Since then, however, the last of the abandoned cacao was cleared, principally for tobacco and rice (*Oryza* species (sp.)).

Banana (*Musa* sp.) and coffee (*Coffea* sp.) are also cash crops for local farmers, but neither is associated with extensive forest clearance. Dessert bananas and banana beer can be sold at local markets, but in 2000 a new banana wilt disease arrived, destroying plantations (Kalyebara *et al.*, 2007). A new coffee wilt disease arrived at the same time (Rutherford, 2006), destroying smallholder coffee plantations. Farmers were advised to destroy all infected banana and coffee plants and not to replant these same crops on affected land for at least 10–15 years. The combined effect of these new crop diseases has been an important factor in household decisions to clear remaining forest and plant alternatives such as tobacco and rice, both of which were promoted locally by agricultural extension services (Agricultural Extension Office, Hoima district, personal communication, 2007). Moreover, neither tobacco nor rice is susceptible to wilt disease and both produce a crop in the first year, offering quick returns.

Tobacco farming is an aggressive driver of deforestation, requiring large amounts of wood for curing and for the construction of drying barns (Geist, 1999). Local farming traditions maintain that tobacco requires fertile (virgin) soil, such that the only available source for most farmers is forest land. Tobacco seedbeds are established by clearing riverbanks to facilitate access to water. Currently, 76% of Uganda's tobacco is produced by British American Tobacco (BAT) (DD International, 2012), with which most Bulindi tobacco farmers are registered.[3] The growth of tobacco farming in Bulindi and its impact on forests are plain to witness. Seeking to maximize production, growing numbers of farmers clear-cut all but the swampiest parts of forest on their land, exposing riverbanks and wetlands, and selling the timber.

In 2006, five riparian fragments used habitually by the chimpanzees averaged 0.3 km² (30 ha) each. These small forests were already substantially reduced; clearance had been under way since around the year 2000. By 2014 these fragments had been further reduced by an estimated 80% (Lorenti, 2014). Thus, in fewer than 15 years, virtually all the chimpanzees' natural habitat had been converted to farmland. Households that have retained some forest on their land generally have sources of income in addition to farming, or prefer not to cultivate tobacco because of personal principles or because they consider it too labor-intensive.

In neighboring Masindi district, chimpanzee habitat has also disappeared rapidly, although there industrial sugarcane production has had more of an impact. Kinyara Sugar Works Ltd. (KSWL) is Uganda's second-largest manufacturer of sugar, operating over much of the area north of Bulindi up to Budongo. First established in the 1960s, KSWL's factory and plantations were rehabilitated in the mid-1990s and expanded quickly thereafter. The ensuing employment opportunities led to an influx of workers from elsewhere in Uganda (Reynolds, 2005; Zommers, Johnson and Macdonald, 2012). To increase production, KSWL operates an outgrower scheme whereby farmers are contracted to plant their own fields with sugar (Zommers *et al.*, 2012). Between 1988 and 2002 the area under sugarcane increased more than 17-fold: from 6.9 km² to 127 km² (690 ha to 12,729 ha), with a corresponding loss of 47 km² (4,680 ha) of forest (8.2%) (Mwavu and Witkowski, 2008, p. 606).

Impact on Human–Chimpanzee Interactions

The major land cover changes taking place around Budongo and Bugoma Forest Reserves have profoundly altered interactions between villagers and resident chimpanzees, changing the relationship from one of coexistence to one of competition. The loss of riparian forests precipitated a sharp increase in people's interactions with chimpanzees. According to Bulindi residents, chimpanzees previously remained within the forests and were seldom seen; yet, as the forests quickly shrank and fragmented, sightings of apes on agricultural land became commonplace, fuelling the prevalent local belief that the chimpanzee population has increased dramatically (McLennan and Hill, 2012).

The extensive forest clearance inevitably caused a critical reduction in wild food (such as through the removal of large fruit-producing trees). However, chimpanzees have flexible diets and quickly learn to exploit agricultural foods (Hockings and McLennan, 2012; McLennan and Hockings, 2014). Chimpanzees reportedly "raid" crops throughout the Budongo–Bugoma corridor (McLennan, 2008). At Bulindi, cacao, guava (*Psidium guajava*), papaya (*Carica papaya*), mango (*Mangifera indica*) and sugarcane are among the chimpanzees' most important foods (McLennan, 2013). Yet crop damage by chimpanzees is not new. The Bulindi chimpanzees have eaten certain crops for decades, most notably the forest cacao. They also ate bananas and mangoes where these were grown at forest edges, but occasional losses of such fruits were apparently accepted. Residents note that the more persistent incursions into village areas by foraging chimpanzees are a recent development, concomitant with clearance of local forests (McLennan and Hill, 2012).

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Farmers in this region are generally tolerant of chimpanzees, perceiving them as less destructive to crops and possessing a "better character" than other wildlife, particularly baboons (*Papio anubis*) (Hill and Webber, 2010; McLennan and Hill, 2012). But as farmers experience improved economic returns from cash cropping sugarcane and tobacco (and increasingly rice), their willingness—or capacity—to tolerate crop losses to chimpanzees and other wildlife declines (Hill and Webber, 2010). Around KSWL this is particularly the case with regard to chimpanzees foraging on sugarcane (Reynolds, Wallis and Kyamanywa, 2003; Webber and Hill, 2014). Outgrower plantations now extend right up to the southern border of Budongo and chimpanzees from the reserve, as well as in the fragments, have been killed for damaging sugarcane (Reynolds, 2005). Chimpanzees do not eat tobacco, but farmers may not wish to tolerate the apes treading on seedlings, in part because the resulting non-consumptive damage to cash crops is viewed in terms of monetary loss. In contrast, previous low-level feeding by apes on domestic fruits, such as mango or guava—traditionally seen as snack food for children—had little impact on household economics (McLennan and Hill, 2012).

The decline in tolerance of chimpanzees is not merely a reflection of changing socioeconomic conditions. Chimpanzees are large-bodied and sometimes threaten or attack people (Hockings and Humle, 2009; McLennan and Hill, 2013). In Bulindi, adult male chimpanzees frequently display aggression on encountering researchers and villagers, for example by "mobbing," charging and pursuing them (McLennan, 2010; McLennan and Hill, 2010). Residents claim that such behavior is recent (McLennan and Hill, 2012). Chimpanzees may direct aggression against humans in response to intensifying disturbance and increasing competitive interactions with people, including over access to crops; moreover, it is not uncommon for people to harass apes in Bulindi, be it by shouting or throwing stones at them, or by chasing them with dogs.

Chimpanzees who range near villages occasionally attack humans physically, particularly children. Five attacks on children have been documented in Bulindi since 2006; while none was fatal, children did sustain serious injuries in three of the cases and required medical treatment at a hospital. Similar chimpanzee attacks—including several fatal ones—have occurred elsewhere within the Budongo–Bugoma corridor (Reynolds *et al.*, 2003; Reynolds, 2005; McLennan, 2008). Although verifying facts can be difficult, in at least some cases chimpanzees seem to have retaliated in response to provocation. Nevertheless, intentional predation on children by chimpanzees has been documented elsewhere in Uganda where forest has been lost to agriculture (Wrangham, 2001). Declining tolerance for chimpanzees therefore has as much to do with fear of physical aggression as crop damage (McLennan and Hill, 2012; Hockings, McLennan and Hill, 2014). Villagers object to the threatening presence of chimpanzees around their homes, even if they do not themselves experience crop losses (McLennan and Hill, 2012).

Changes in chimpanzee behavior are challenging formerly benign attitudes towards them. Even if people do not hunt them for food, as in this part of Uganda, a "conflict threshold" exists beyond which people are unlikely to tolerate living with chimpanzees unless benefits outweigh costs substantially. This threshold is fast looming in Bulindi and elsewhere in the fragments, as reflected in an apparent increase in retaliatory killings and the use of lethal crop protection methods, including large steel "mantraps" (Reynolds, 2005; McLennan *et al.*, 2012). While mantraps are usually intended for other wildlife, some farmers use them to protect cash crops such as sugarcane from chimpanzees—something they apparently would not have done previously (McLennan and Hill, 2012). Snares and traps seem to be taking a toll on the fragmented chimpanzee population; in Bulindi, for example, at least five individuals—or roughly 20% of this small community—were trapped within four years (McLennan *et al.*, 2012).

Unless upward trends in forest clearance and interactions between people and apes are reversed, survival prospects for the "village chimpanzees" are bleak, negating the corridor value of the riparian forests (McLennan and Plumptre, 2012). Any intervention strategy must ensure effective protection of remaining habitat alongside planned and sustained forest restoration to provide an adequate resource base for the existing and future chimpanzee population. Such an approach would require tobacco and sugarcane companies to commission environmental impact assessments, to be conducted by independent, external agencies. In addition, culturally sensitive education programs are needed to encourage human behavior that reduces aggressive interactions with apes (Hockings and Humle, 2009).

Effective crop protection measures are also required to help farmers safeguard their livelihoods. Around Budongo, on-farm trials have tested methods such as barriers, alarms, repellents and systematic guarding (patrolling farm boundaries); guarding was identified as the most effective for reducing crop losses to chimpanzees. Full-time guards were the most valuable, but part-time, randomized guarding schedules were also effective at reducing crop losses to non-human primates (Hill and Wallace, 2012).

Such crop-protection methods are labor-intensive, however, as they require an adult presence on farms for extended periods during daylight hours. Consequently, farmers often combine guarding with other farming tasks; yet, to be effective, guarding should be the main activity of the person tasked with it. In the short term, external financial support to employ full-time guards, deployed at key sites, and operating a randomized guarding schedule, could reduce crop losses and help prevent further escalation of aggressive interactions between people and apes. In the longer term, research is needed to develop alternative, cost-effective crop protection strategies.

Important lessons can be learned from interactions between humans and carnivores, in which people's willingness to tolerate large-bodied predators is often linked to deep-rooted social beliefs rather than perceived or experienced threats (Marchini and Macdonald, 2012). Increasing people's willingness and capacity to tolerate apes requires a combination of awareness raising and financial and social incentives (Treves and Bruskotter, 2014).

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Another mechanism is the translocation of wild orangutans, generally from a site where they are considered a problem, to a site where they will not come into conflict with humans; as described below, however, this option is deemed a partial solution (Beck *et al.*, 2007). Indeed, conservationists advocate that this option be used only as a last resort, as it carries considerable risk for the animals and people involved. Nevertheless, it is often regarded as the only solution to save the lives of animals threatened by deforestation and the rapid development of industrial oil palm monocultures.

Rescue Centers and Problems Faced with Rescued, Translocated and Reintroduced Orangutans

> “One way to facilitate the reintroduction of captive orangutans into the wild is to develop public–private partnerships to secure the use of concessions as release sites.”

As described in Case study 1.1 on orangutan rescues in Indonesia, rehabilitation centers in Borneo have rescued an average of 20 orangutans every year since 2009 in West Kalimantan and an average of 67 every year since 1999 in Central Kalimantan; on Sumatra, the average stands at 26 orangutans every year since 2002. Given the large number of rescues and the ongoing need to assist orangutans in captivity, rescue and rehabilitation centers across Indonesia are functioning at full capacity. While the centers aim to release orangutans back into the forest, the process is costly and difficult; in some cases, orangutans cannot be released as they have been irreversibly damaged by their experiences and would no longer be able to survive in their native habitats.

Reintroduction sites must meet a number of criteria outlined by the International Union for Conservation of Nature (IUCN) and rescue centers must also abide by Indonesian guidelines before releasing an orangutan into the wild. One of the most important regulations stipulates:

> Re-introduction should not endanger resident wild ape populations [. . . ,] populations of other interacting native taxa, or the ecological integrity of the area in which they live (Beck *et al.*, 2007).

If unprecedented deforestation is occurring at an alarming rate, however, finding a suitable reintroduction site where no resident wild orangutan population resides is challenging.

In 2009, in an effort to safeguard orangutans, the Indonesian government developed and signed the Orangutan Indonesia Conservation Strategies and Action Plan 2007–2017 (MOF Indonesia, 2009). This action plan pledges to stabilize all remaining wild populations of orangutans by 2017 (Wich *et al.*, 2011, 2012b). One of the goals of this plan was the release of all rescued orangutans into the wild by 2015. While this aim was theoretically feasible at the time of the development of the plan, several practical considerations made the 2015 target unrealistic. These include the lack of suitable orangutan reintroduction sites; the presence of resident wild orangutans in most of the remaining suitable forests; and the large number of forested areas that are earmarked for conversion, being converted or already converted into oil palm plantations.

One way to facilitate the reintroduction of captive orangutans into the wild is to develop public–private partnerships to secure the use of concessions as release sites. This approach would require each oil palm and timber company to establish not only conservation areas within its concessions, but also human–orangutan conflict rescue units in each subsidiary plantation, to allow for rapid responses to conflict situations. Companies would also be called on to develop strategies for conservation management of

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orangutan populations at the landscape level; in so doing, they would need to involve different stakeholders, including other companies and concessions. Furthermore, as advocated in the Best Practice Guidelines for the Prevention and Mitigation of Conflict between Humans and Great Apes (Hockings and Humle, 2009), companies should also develop and implement standard operating procedures, not least to foster best practices and procedures for the mitigation of human–orangutan conflict in each concession. These steps would contribute to a more sustainable future for orangutan populations in a landscape of continued agricultural development.

The Roundtable on Sustainable Palm Oil (RSPO) principles and criteria are a good starting point for making oil palm cultivation more compatible with a government's goals of maintaining viable populations of threatened orangutans (Wich *et al.*, 2012b). Following these principles and criteria would also help to reduce the number of orangutans who need to be rescued as a result of oil palm development. However, the implementation of RSPO procedures for sustainability is not yet optimal and has proven a challenge. For an assessment of the RSPO's functions and impact, see Chapter 5.

The killing of orangutans displaced by plantation development or other forms of destructive land use, together with the fragmentation of the remaining intact forest, constitutes a conservation emergency for these great apes (Nellemann *et al.*, 2007), as demonstrated by the rates at which orangutans continue to enter captivity. The situation is further complicated by the complexity of rehabilitation, translocation and reintroduction. A response to this crisis requires commitment from and participation of all stakeholders involved in industrial agriculture, including producers, manufacturers, retailers, investors, consumers, local people, and governments.

Agricultural Industry Engagement in Ape Conservation and Mitigation Strategies

Agricultural Practices and Land Use Management

Understanding the requirements of both displaced and isolated ape populations is essential for effective land use and conservation planning and management (Sha *et al.*, 2009; Hoffman and O'Riain, 2012). Indeed, it is vital to understand where wild apes and other threatened wildlife overlap with protected areas and areas propitious to large-scale development, such as industrial agriculture, so as to be able to inform conservation planning (Wich *et al.*, 2012b). Land use planning can provide the direction needed to coordinate economic development across a region and to regulate the conversion of land and property uses (UNECE, 2008). This includes decisions on balancing social and economic development, enhancing communication networks, accessing information and knowledge by all affected stakeholders, reducing environmental damage and enhancing protection for natural resources, natural heritage and cultural heritage. Comprehensive, landscape-wide planning could enable stakeholders—including governments, industry, civil society, communities and individuals—to assess competing claims for land use in the context of planned changes to habitats.

"Land use planning can provide the direction needed to coordinate economic development across a region and to regulate the conversion of land and property uses."

In many countries, the laws and regulations regarding the protection status of forests are contradictory and unclear (see Chapter 4). In Indonesia, for instance, the laws and regulations regarding the destruction of forest and conversion of peatland need to be harmonized with the legislation that protects orangutans and outlaws killing them. Specifically, the expansion of agricultural activities into legally protected orangutan

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Photo: The expansion of agricultural activities into legally protected orangutan ranges represents a breach of national laws on species protection. SOCP orangutan rescue from an oil palm plantation. © Paul Hilton for SOCP

ranges represents a breach of national laws on species protection. Urgent efforts are needed to focus on improving yields in current plantations and on expanding concessions in already deforested areas (Wich *et al.*, 2012b)—goals achievable through the use of improved varieties of crops and more effective agricultural practices, such as conservation agriculture (see Box 1.4).

In Africa, the challenge is that in some countries with the right conditions for oil palm and other large-scale agricultural development—such as Angola, the DRC, Gabon, Ghana, Ivory Coast, Liberia, the Republic of Congo and Sierra Leone—more than two-thirds of areas suitable for oil palm development outside of protected areas overlap with ape distribution (Wich *et al.*, 2014). Many of these areas, especially across West Africa, already represent degraded landscapes, where chimpanzees have in some cases been surviving for generations, ironically, it seems, thanks to the presence of wild oil palms, which may be a keystone species for some of these communities (Brncic *et al.*, 2010).

Wherever apes can survive and thrive on natural resources available to them and share the landscape with people, agricultural development needs to focus on maintaining natural resources, forest patches and ecosystem services; preserving and promoting connectivity to ensure population viability; and managing negative attitudes toward apes and crop loss (Koh and Wilcove, 2008a; McShea *et al.*, 2009; SWD, 2012; Ancrenaz *et al.*, 2015). Such management strategies and schemes may vary according to the growth stage of the commercial crops. Once oil palms reach maturity in a plantation, for instance, cultivators can remove measures such as trenches and strips of bare land that act to protect oil palm saplings from orangutans; to promote species conservation, these elements can be replaced with bridges to encourage orangutan dispersal, nesting and low-impact foraging on fruit (Ancrenaz *et al.*, 2015). In fact, the effectiveness of trenches and bare strips of land in protecting plantations from apes and other wildlife remains to be ascertained. Further research is also required to assess the value of implementing other types of buffers around plantations with respect to different ape species, particularly with regard to plant species composition and recommended width.

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Another way of preventing crop losses or damage is to switch land use activities or promote low- or potentially low-conflict crops (Hockings and McLennan, 2012). Such strategies may not always result in equal or greater economic benefit to farmers or landowners; however, some crops can help balance both economic and conservation objectives. Research findings demonstrate that cashew nut (*Anacardium occidentalis*) production across a forested agricultural matrix around the Cantanhez National Park in Guinea-Bissau, West Africa, benefited both wild chimpanzees and people, providing an example of co-utilization. While this tree species is of high economic value, it is also nutritionally beneficial to wild chimpanzees. The apes focus on the fleshy part of the fruit, leaving behind the valuable casing for farmers to harvest; the seed—that is, the

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cashew nut—is found in the casing (Hockings and Sousa, 2012). Although this crop species appears to meet both livelihood and conservation objectives, it must be noted that unmanaged expansion of cashew plantations or any other low-conflict crop of high market value could result in significant habitat loss for wild chimpanzees and other apes; such expansion can also affect market prices, thus affecting the crop's value to farmers.

Translocation and Other Mitigation Strategies

"Releasing individuals into areas that are already populated by conspecifics can lead to intra-specific aggression and disease transmission."

In areas where orangutans live, wildlife translocations—the "human-mediated movement of living organisms from one area, with release in another" (RSG and ISSG, 2012, p. 1) —have generally been implemented only as a last resort to save individual apes, as noted above (Yuwono *et al.*, 2007).

Translocations often involve individual orangutans in extremely poor physical and psychological condition (Hockings and Humle, 2009). As such individuals often require veterinary support, they tend to be placed in rehabilitation centers, which can facilitate their recovery and potential future release back into the wild. In other cases, orangutans may be rescued after plantation workers or local people signal their presence to local non-governmental organizations or authorities (G. Campbell-Smith and I. Singleton, personal communication, 2014). In some cases, these orangutans are directly translocated elsewhere, without prior assessment as to whether the situation at the site of origin is truly unmanageable—meaning that the negative impacts on apes and people cannot be mitigated or prevented by other means—and without consideration of the full implications of their release at the destination site (S. Wich, personal communication, 2014). By offering quick-fix solutions to problems between people and endangered wildlife, such initiatives can effectively prevent consultation among all stakeholders and expert assessments aimed at understanding, reducing and mitigating the issue.

Unplanned and mismanaged translocations are often carried out without prior assessment of the chances of survival of individuals to be released or the impact of their presence on wild conspecifics and other wildlife at the release site. Releasing individuals into areas that are already populated by conspecifics can lead to mortalities as a result of intra-specific aggression—especially among male chimpanzees (Goossens *et al.*, 2005b; Humle *et al.*, 2011)—or disease transmission, if at-risk individuals are not appropriately quarantined and tested prior to being released (Beck *et al.*, 2007; Kavanagh and Caldecott, 2013). Such translocations can also disseminate "conflict issues" if relocated individuals had habitually foraged on crops or approached human settlements in their area of origin. Such "bad habits" can get passed on to other individuals at the release site and cause problems with the surrounding communities.

Finally, it is clear that any post-release monitoring or pre-release site assessment and translocation initiatives are financially and logistically costly (Hockings and Humle, 2009). It is therefore essential to develop a coherent strategy around ape translocations, not only to ensure sustained funding, but also to integrate expert assessments of suitable release sites that are unlikely to incur future large-scale development and conflict issues with local people, as well as adequate post-release monitoring techniques and methodologies (Colin *et al.*, 2014). Nevertheless, it should be borne in mind that translocations and relocations are rarely useful or feasible options, given that suitable habitats are often scarce and the processes are ethically and logistically complicated, especially for great ape species that live in complex social groupings, such as bonobos, chimpanzees and gorillas (Hockings and Humle, 2009).

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Deterrents

To date, very few studies have tested alternative mitigation approaches and deterrent techniques; the ones that have been undertaken focus on small-scale farms, which are more vulnerable to damage than large-scale commercial plantations. Still, their results can serve to inform mitigation approaches applicable to industrial agriculture. As indicated in Case study 1.2, experimentation has identified different locally appropriate techniques aimed at reducing crop damage by primates. While systematic guarding proved the most successful in reducing primate crop damage, other helpful techniques included the use of impenetrable living jatropha hedges, multi-strand barbed wire fences combined with camphor basil (*Ocimum kilimandscharicum*) planted along the bottom of fences and rope fences coated with chili paste. On their own, however, barbed wire fences were not always effective and simple ropes with bells were entirely ineffective. These measures vary in their costs and practical implementation, as a barbed wire fence is expensive and a hedge cannot readily be moved around in a landscape characterized by shifting agriculture, although such an approach could potentially be highly effective in protecting permanent gardens (Hill and Wallace, 2012).

While the large-scale use of hedges and barriers, such as fences, can be effective in terms of reducing crop damage, it can be problematic for wildlife as it can interfere with ranging and dispersal behaviors (Hayward and Kerley, 2009). Therefore, the implementation of such boundaries requires careful analysis and prior understanding of the ecology and local ranging of different wildlife species in the area. Research into effective barriers to protect crops from wildlife has also shown that the implementation of tested measures can lead wildlife to unprotected neighboring farms, displacing the issue and thereby highlighting the importance of implementing mitigation schemes simultaneously across landscapes, including all neighboring farms and agricultural developments. Persistent efforts could eventually lead to a significant decrease in crop damage events, so long as individual apes have adequate natural forage available. Year-round availability of, and access to, natural foods should therefore be assessed in advance, to ensure that preventing access to crops does not nutritionally compromise ape survival (Hill and Wallace, 2012).

In Sumatra, trials have been undertaken to test the effectiveness of noise deterrents and netting of trees to keep orangutans from foraging on fruit orchards in an agro-forestry landscape. The implementation of these measures improved local farmers' attitudes towards orangutans. A comparison of pre-trial and post-trial raiding events revealed that netting of trees, as opposed to noise deterrents, proved highly effective across farms where these approaches were tested; on control farms where no deterrents were employed, there was no difference between pre-trial and post-trial crop damage incidents. Although netting trees proved most effective, as it resulted in a significant increase in crop yield, farmers failed to persist in employing this technique after the trials ended, probably due to the related expense and logistical complexity (Campbell-Smith, Sembiring and Linkie, 2012).

Another way to mitigate instances of aggression is to change people's behavior towards apes (Hockings and Humle, 2009). In some cases, preventing surprise encounters via maintenance of shared paths to increase visibility can act to reduce aggressive incidents (Hockings and Humle, 2009). Educating plantation workers and people in the locality about apes and advising them on how to behave when they see an ape can also minimize the likelihood of aggression and reduce the risk of any escalation during encounters.

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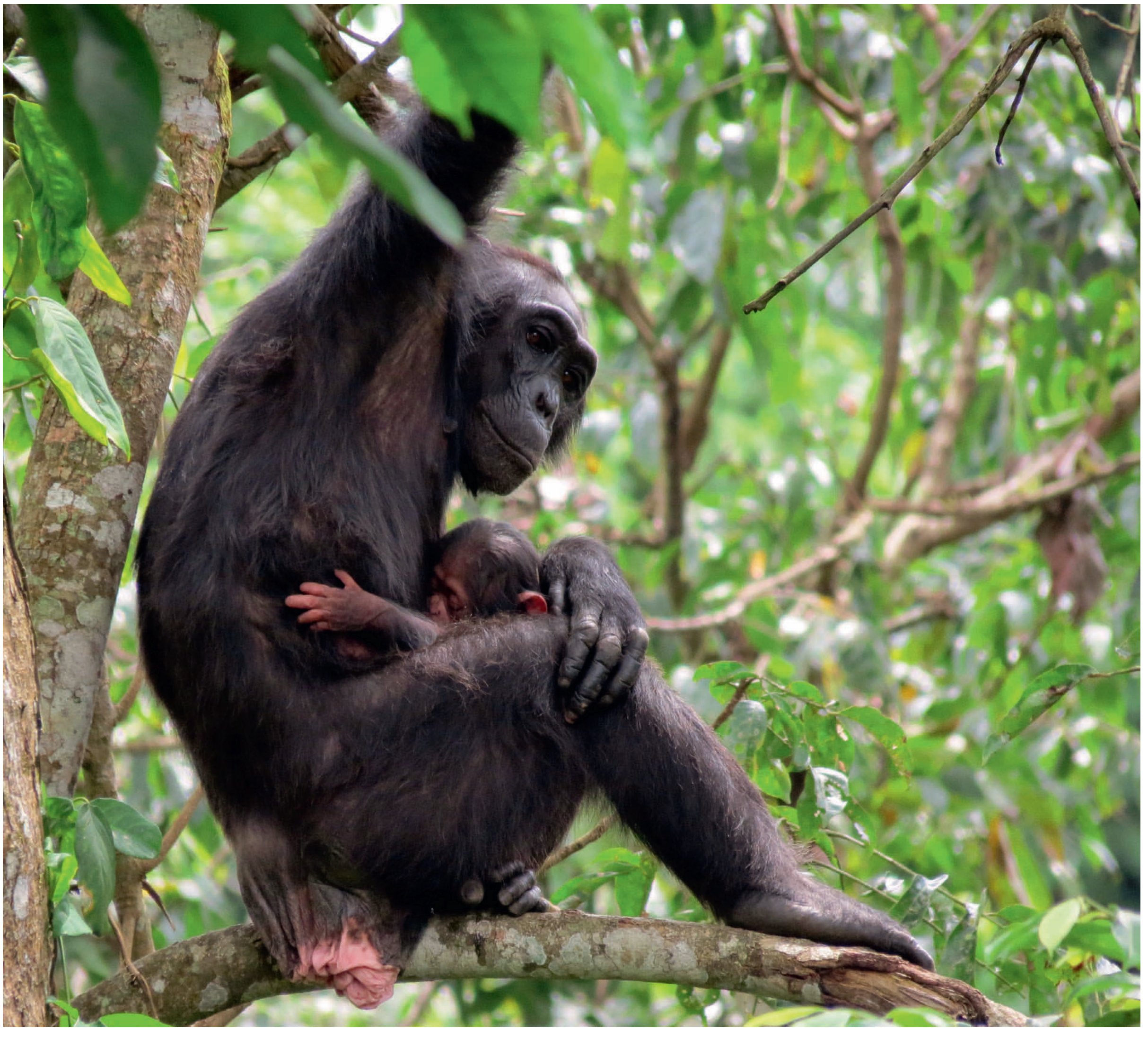
Photo: Unless upward trends in forest clearance and interactions between people and apes are reversed, survival prospects for the Bulindi village chimpanzees are bleak. Mother and baby chimpanzee at Bulindi, Uganda.

The Roles of Producers, Buyers and Consumers

The previous sections place much emphasis on the responsibility of growers and producers of commodities to improve the ability of apes to utilize and move through plantations; however, it is also important to highlight the role of the large-scale buyers and consumers of these commodities in terms of promoting and incentivizing better management practices. Since the current price of RSPO-certified palm oil is not significantly higher than that of non-certified oil, producers do not have much of an incentive to comply with certification requirements, including species-tolerant practices (see Chapter 5). Yet the adoption of such practices could be encouraged through a variety of approaches, including the promotion of no-deforestation and "no-kill" plantation policies, demands from consumer companies and the establishment of effective enforcement and monitoring of adherence to such policies. See Chapter 5 for an analysis of the role and impact of the RSPO in the conservation of apes in an industrial landscape.



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Conclusion

Agricultural expansion across ape ranges, especially on an industrial scale, affects apes in two fundamental ways: through the destruction of their habitat (which also provides increased access to previously remote forests) and through increased competition over crops and land, which leads to negative interactions between people and apes. The latter is especially critical for ape species and populations that are likely to utilize cultivated crop species and venture close to human areas in modified landscapes, such as chimpanzees and orangutans.

There is an urgent need for ape range countries to balance industrial agricultural development with the protection of habitat and endangered species. Although it is illegal to kill apes in all the countries in which they are found, agriculture leads to significant population declines, through habitat destruction as well as direct killing. Land use plans do not adequately consider aspects such as conservation value, species diversity or abundance in the identification of areas for agricultural development—even though these factors are critical. Land use management could be improved through the integration of reliable empirical data on ape distribution and occurrence in environmental impact assessments. Including the mitigation hierarchy in decision-making is also critical, as the approach emphasizes the strategies of avoidance, mitigation, restoration and biodiversity offsets.

At the local level, any large-scale industrial agricultural activity should be informed by a solid understanding of how human–wildlife interactions affect people's livelihoods and shape people's perceptions, attitudes and the value they attach to apes. Moreover, effective strategies for preempting human–ape conflict require a firm appreciation of ape ecology and ranging behavior. In this context, it is just as important to ascertain how barriers can effectively mitigate crop damage as it is to recognize that they can also displace problems to areas where mitigation strategies cannot be implemented. Such informed approaches can help to prevent or manage any escalations and retaliatory behaviors resulting from human–ape interactions. In an effort to minimize cumulative impacts and risks to both people and apes, it is useful to adopt a broad perspective—one that will allow for assessment of all the impacts of industrial-scale agricultural developments and related operations. Clearly, such efforts require appropriate interdisciplinary and cross-disciplinary expertise, as well as strong local participation and engagement of all stakeholders.

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Endnotes

1 Conversions were calculated using the yearly average currency exchange rate for 2010: 0.785, as per IRS (n.d.).

2 The figure is calculated by dividing the current population—573,903 (UBOS, 2014, p. 7)—by the total land area; however, there is no consensus on land area of the district. Land area is thus calculated based on the total population and population density as reported in the 2002 census, yielding an area of 3,602 km² (UBOS, 2006, pp. 47, 53).

3 At this writing, British American Tobacco Uganda was reportedly ceding its leaf growing operations to another company (*Sunday Monitor*, 2014).

Photo: Crops found in ape ranges include acacia, cacao, coffee, eucalyptus, maize, oil palm, peanuts, rubber, sugarcane and tea. © Ulet Ifansasti/Greenpeace

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