Photo: There was a 50% total decline in the Bornean orangutan between 1999 and 2015 and up to 80% of them may vanish by 2080. © Paul Hilton/Earth Tree Images

CHAPTER 7

The Status of Apes: A Foundation for Systematic, Evidence-based Conservation

Introduction

Starting in the 1970s, biodiversity loss took on the dimensions of a global conservation crisis (Junker *et al.*, 2012). In view of evidence that human activities were threatening the survival of apes, conservationists recognized the need to develop a better understanding of how many individuals remained in the wild. Scientists have been refining population survey methods ever since. By the end of the decade, systematic field survey data collection allowed for the inference of abundance, enabling large-scale systematic surveys across great ape ranges. Continuous advances in methods development and the creation of the A.P.E.S. database—a project of the International Union for Conservation of Nature (IUCN) Species Survival Commission

—have further enabled the compilation of large survey data sets to estimate total ape abundance for all 14 great ape taxa in Africa and Asia (IUCN SSC, n.d.-a). The A.P.E.S. database is currently being expanded with the aim of making reliable population estimates available for the 20 gibbon taxa.

This chapter presents and contextualizes broad abundance estimates. It reviews the main threats to all ape taxa; examines the history of surveying apes, current methodology and promising innovations; and assesses the abundance data to identify population trends. The chapter goes on to provide an overview of evidence-based conservation and its advantages. It introduces the concept of horizon scanning as a way to anticipate threats, mitigate their impacts and capitalize on opportunities (Sutherland *et al.*, 2019b). Detailed ape abundance estimates are presented in the online Abundance Annex on the *State of the Apes* website, www.stateoftheapes.com.

The key findings include:

- Africa is home to about 730,000 great apes, including fewer than 300 mature Cross River gorillas, whose population is by far the smallest; in Asia, the total orangutan population is around 150,000, including about 800 Tapanuli individuals.
- All 20 gibbon taxa make up an estimated 600,000 individuals, one-quarter of whom are Bornean white-bearded gibbons.
- All ape taxa except the mountain gorilla are in significant decline. The population size of both Grauer's gorilla and the western chimpanzee dropped by about 80% between the 1990s and 2015. The Bornean orangutan experienced a 50% decline between 1999 and 2015; up to 80% of these great apes may vanish by 2080. All but one of the 20 gibbon taxa have suffered a reduction ranging from 50% to 80% of their populations since the 1970s.
- Urgent action is required to prevent catastrophic declines of small, isolated gibbon populations, such as the 34 remaining Hainan gibbons in on an island off southern China and the 200 Gaoligong gibbons on the Chinese mainland.
- The most pressing threats to all apes include habitat loss and fragmentation; infectious disease; poaching for wild meat and the live ape trade; and human–wildlife conflicts.
- To be accurate, assessments of conservation efforts require up-to-date information on ape populations and the threats facing them.
- The further development of an evidence-based conservation framework, building on concepts from socioecological and complex systems, is essential.
- There is a need for more systematic evaluations of conservation strategies so that effective approaches may be identified and strengthened with the aim of ensuring the survival of all ape species.

The Importance of Information on Apes

The IUCN Red List categorizes all ape taxa as "critically endangered" or "endangered," with the exception of the "vulnerable" eastern hoolock (*Hoolock leuconedys*). If apes are to avert extinction, they require immediate, effective conservation measures at the local, national and international levels (see the Apes Overview). To be able to design and evaluate such actions, conservationists principally rely on:

- baseline abundance data, which reveal how many individuals of targeted species are left in the wild at the start of an intervention;
- ongoing monitoring of ape populations —through systematic surveys and bio-

monitoring—to be able to infer ape population density, abundance and changes; and

- information on the distribution and the intensity of the prevailing causes of population contractions, such as hunting, habitat loss and fragmentation, and infectious diseases.

Such data allows for quantitative trend analysis as well as assessments of the importance of different habitats for the conservation of apes, including potential release sites for the reintroduction or translocation of individuals and the most appropriate sites for the creation of new protected areas (Campbell, Cheyne and Rawson, 2015; Cheyne, 2006; Plumptre and Cox, 2006). The IUCN uses such information to produce its Red List, while other conservation organizations cite it in their reporting under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Great Apes Survival Partnership (GRASP) of the United Nations Environment Programme (CITES, n.d.; GRASP, n.d.; IUCN, 2019).

Threats to Apes

The most pressing threats to all apes include habitat loss and fragmentation; infectious disease; poaching for wild meat and the live animal trade;[1] and killing in human–wildlife conflict. Habitat loss exacerbates the poaching threat, while the killing of adult apes enables the opportunistic capture of infants for sale on the illegal market (Plumptre *et al.*, 2015; Singleton *et al.*, 2017).

Photo: The most pressing threats to all apes include habitat loss and fragmentation, infectious disease, poaching for wild meat or killing in conflicts. Large-scale hardwood timber extraction, Gabon. © Jabruson (www.jabruson.photoshelter.com)

TABLE 7.1

Main Threats Facing African Great Apes, by Taxon

Taxon	Main threats	Sources
Bonobo *Pan paniscus*	**Disease**	Fruth *et al.* (2016); Hickey *et al.* (2013); IUCN and ICCN (2012); Sakamaki, Mulavwa and Furuichi (2009)
	Habitat loss, fragmentation and degradation due to shifting agriculture, mining and infrastructure development	
	Poaching (for wild meat; traditional medicine and ritual; indiscriminate). N.B. Trafficking of live orphans is a by-product of the wild meat trade	
Central chimpanzee *Pan troglodytes troglodytes*	**Disease**	Maisels *et al.* (2016); Strindberg *et al.* (2018)
	Habitat loss, fragmentation and degradation due to extractive industries, commercial agriculture and infrastructure development	
	Poaching (for wild meat; indiscriminate). N.B. Trafficking of live orphans is a by-product of the wild meat trade	
Nigeria–Cameroon chimpanzee *Pan t. ellioti*	**Disease**	Oates *et al.* (2016)
	Habitat loss fragmentation and degradation due to shifting and commercial agriculture	
	Poaching (for wild meat; indiscriminate; human–wildlife conflict)	
Western chimpanzee *Pan t. verus*	**Disease**	Humle *et al.* (2016); Kühl *et al.* (2017)
	Habitat loss, fragmentation and degradation due to shifting and commercial agriculture, extractive industries and infrastructure development	
	Poaching (for wild meat; traditional medicine and ritual; indiscriminate; human–wildlife conflict; for live capture)	
	Trafficking of live animals	
Cross River gorilla *Gorilla gorilla diehli*	**Disease**	Bergl *et al.* (2016)
	Habitat loss, fragmentation and degradation due to shifting and commercial agriculture	
	Poaching (for wild meat; indiscriminate; human–wildlife conflict)	
Grauer's gorilla *Gorilla beringei graueri*	**Disease**	Plumptre *et al.* (2015, 2016b)
	Habitat loss, fragmentation and degradation due to artisanal mining, shifting cultivation and commercial agriculture	
	Poaching (for wild meat; traditional medicine and ritual; indiscriminate; human–wildlife conflict; collateral/incidental killing). N.B. Trafficking of live orphans is a by-product of the wild meat trade	
Mountain gorilla *Gorilla b. beringei*	**Disease**	Gray *et al.* (2010); Robbins *et al.* (2011); Roy *et al.* (2014)
	Poaching (indiscriminate; human–wildlife conflict; politically motivated/civil unrest)	
Western lowland gorilla Gorilla g. gorilla	Disease	
	Habitat loss, fragmentation and degradation due to extractive industries, commercial agriculture and infrastructure development	Maisels *et al.* (2018); Strindberg *et al.* (2018)
	Poaching (for wild meat; indiscriminate; human–wildlife conflict). N.B. Trafficking of live orphans is a by-product of the wild meat trade	

Notes: This table does not quantify or compare the impact levels of listed threats. In addition to these threats, climate breakdown affects all great ape taxa (IUCN, 2020).

Source: GRASP and IUCN (2018, table 5)

This chapter compiles information on direct and indirect threats affecting ape populations from all available survey reports, both published and unpublished; from peer-reviewed publications; and based on expert opinion. Information on the conservation status of each taxon reflects the most recent assessments in the IUCN Red List (IUCN, 2019).

Threats to African Great Apes

Poaching for wild meat, habitat loss and degradation, and infectious diseases are common threats to all great apes in Africa (Butynski, 2001; GRASP and IUCN, 2018; IUCN, 2014; IUCN and ICCN, 2012; Kormos *et al.*, 2003; Plumptre *et al.*, 2010). In some areas, the trafficking of live infants is among the most significant threats to great apes (GRASP and IUCN, 2018).

Habitat loss can have various causes across range countries, such as industrial agriculture, extractive industries and large-scale development activities, including the construction of dams and other infrastructure projects (GRASP and IUCN, 2018; Kormos *et al.*, 2014). The ongoing conversion of habitats into plantations threatens African great apes much as it has apes in Southeast Asia (Wich *et al.*, 2014). Infrastructure and industrial development is proliferating throughout Africa and will exacerbate pressure on great apes and their habitats (Kormos *et al.*, 2014).

Table 7.1 lists the threats affecting all great apes in Africa. Annex III presents threats to great ape populations in each African range country. Detailed descriptions of threats facing African great apes can be found in GRASP and IUCN (2018) and IUCN (2019).

Threats to Asian Great Apes

Forest loss due to conversion for agriculture, illegal logging, mining infrastructure and rural development; fires; and poaching are the main threats to the Bornean orangutans and are the cause of the dramatic reduction of their population in the past decades (GRASP and IUCN, 2018; Santika *et al.*, 2017; Voigt *et al.*, 2018; Wich *et al.*, 2008, 2012b). Sumatran and Tapanuli orangutans are threatened by legal and illegal logging for timber and by habitat conversion for agriculture, as large areas of forests continue to be converted to oil palm plantations. Unless measures are taken to curtail the current rate of forest conversion and loss, 4,500 Sumatran orangutans will disappear by 2030 and 45,300 Bornean orangutans by 2050, as a result of habitat fragmentation and loss, alongside the killing and capture of these species (Voigt *et al.*, 2018; Wich *et al.*, 2016).

Habitat loss and poaching are the main causes of orangutan decline in both Indonesia and Malaysia. The development of oil palm plantations in both countries has played a major role in the destruction of great ape habitat (GRASP and IUCN, 2018).

More information on the threats facing orangutans is available in GRASP and IUCN (2018) and on the IUCN Red List website (IUCN, 2019). Threats to all orangutans are presented in Table 7.2.

Threats to Gibbons

Many threats affect gibbons. Some direct threats have a larger impact on gibbon populations than others, but no quantitative comparisons are possible. As several species cross international boundaries, threats vary even within species, based on location. In some places, gibbons are protected by local cultures and traditions, whereas in other areas the same species may be threatened. Nevertheless, all gibbons are affected by:

- **climate breakdown**, which leads to range shifts and possible changes in food availability (Dunbar *et al.*, 2019; Struebig *et al.*, 2015a, 2015b);

TABLE 7.2

Threats Facing Asian Great Apes, by Taxon

Species	Main threats	Source
Bornean orangutan *Pongo pygmaeus*	**Habitat loss, fragmentation and degradation** due to agriculture, extractive industries and fire	Ancrenaz *et al.* (2016a); Voigt *et al.* (2018)
	Poaching (for wild meat; human–wildlife conflict)	
Sumatran orangutan *Pongo abelii*	**Habitat loss, fragmentation and degradation** due to agriculture, extractive industries and infrastructure (roads)*	Singleton *et al.* (2017); Wich *et al.* (2012a, 2016)
	Poaching (conflict-related)	
Tapanuli orangutan *Pongo tapanuliensis*	**Habitat loss, fragmentation and degradation** due to agriculture, extractive industries and construction of large-scale infrastructure (such as hydroelectric projects)	Nowak *et al.* (2017); Wich *et al.* (2012a, 2019)
	Poaching (for wild meat; conflict-related)	Wich *et al.* (2012a, 2019)

Note: * While habitat loss is a direct threat, it results in indirect threats such as the illegal trade in apes (Singleton *et al*., 2017). In addition to these threats, climate breakdown affects all great ape taxa (IUCN, 2020). This table does not quantify or compare the impact levels of listed threats.

Source: GRASP and IUCN (2018, table 9)

- **disease transmission**, especially as a result of contact with humans (such as through the live animal trade) and due to susceptibility to new diseases, including Covid-19 (Campbell, Cheyne and Rawson, 2015);
- **habitat loss, fragmentation and degradation** due to artisanal mining, infrastructure development, and shifting local and commercial agriculture (Ancrenaz *et al.*, 2015; Cheyne *et al.*, 2016a; Gray, Phan and Long, 2010; Kakati, 2000); and
- **poaching,** which can be either intentional or incidental, and may be related to resource conflicts; local markets; traditional medicinal practice and other customs; and subsistence hunting and the wild meat trade, whose by-products include the trafficking of live orphans (Nijman, Yang Martinez and Shepherd, 2009; Yin *et al.*, 2016).

The volume of gibbons available for sale on social media and used as photo props indicates that the extraction of infants from the wild is ongoing, and possibly increasing. Demand for these apes is fueled by their growing exposure as pets, including online, and the proliferation of gibbons as photo props in hotels and on beaches that are frequented by tourists (Brockelman and Osterberg, 2015; Osterberg *et al.*, 2015).

While it is not possible to estimate the precise impact of hunting for wild meat on gibbons, research indicates that populations in China, the Lao People's Democratic Republic (PDR), Myanmar, Thailand and Viet Nam are particularly at risk; hunting for cultural purposes takes place in the Mentawai Islands of Indonesia; and removal of gibbons from the wild for the live animal trade (Phoonjampa and Brockelman, 2008; Quinten *et al.*, 2014; Smith *et al.*, 2018; Yin *et al.*, 2016). In general, poachers for wild meat do not specifically target gibbons. The killing of a mother may enable the opportunistic capture of infants for sale into the live animal trade (Osterberg *et al.*, 2015).

The Status of Apes

Historical Records of Ape Status

Great Apes

Historical records on the status of great apes date back to the 19th century (Schlegel and Müller, 1839–1844; Schouteden, 1930; Schwarz, 1929). Most of these sources document the distribution or commonness of great apes in different African and Asian landscapes; others comprise anecdotes from travelers and colonial officials who reported on the presence or absence of great apes in particular locations (Coolidge, 1933; Kramm, 1879).

Many provide maps or written reports of where great apes were sighted or collected for museums and zoological institutions (Coolidge, 1933; Miller, 1903).

It was only in the mid-20th century that scientists arrived at initial estimates of the number of individual apes living on the planet. At the time, broad ranges were provided as population figures for some taxa, as abundance was inferred based on experts' guesses, rather than calculated using field survey data. In 1960, scientists estimated that there were more than one million chimpanzees (*Pan troglodytes*), fewer than 100,000 western gorillas (*Gorilla gorilla*) and 3,000–15,000 eastern gorillas (*Gorilla beringei*),[2] while the size of the bonobo (*Pan paniscus*) population was thought to be about 100,000 in the 1970s (Butynski, 2001; Emlen and Schaller, 1960). For a long period, bonobos were thought to be eastern chimpanzees; they were only recognized as a separate taxon in 1929 (Schwarz, 1929). Meanwhile, primatologists with a focus on Asian great apes speculated that 15,000–90,000 Bornean orangutans (*Pongo pygmaeus*) remained in the 1970s and 1980s; they estimated that only 5,000–15,000 Sumatran orangutans (*Pongo abelii*) persisted in the wild in the 1970s and revised that figure to about 6,600 in 2000 (Rijksen, 1978; Wich *et al.*, 2008).

Scientists only began to collect field survey data systematically to infer great ape abundance in the late 1970s and early 1980s (Teleki and Baldwin, 1979; Tutin and Fernandez, 1984). In the field of primatology, the task was facilitated through the introduction of distance sampling methods, which allowed for large-scale, systematic surveys across great ape ranges (Buckland *et al.*, 2010). In the 1990s and the following decade, the development of additional techniques enabled scientists to generate abundance estimates for many species, which provided the basis for calculating population sizes of all 14 currently recognized taxa of great ape (see the Apes Overview).

Gibbons

Gibbons persist across much of their historic range, with 20 species covering 11 countries (Alfano *et al.*, 2016; Carbone *et al.*, 2014; Kheng *et al.*, 2018; see the Apes Overview).[3] Recent extinctions have occurred in China, however: two species have been extirpated in the past 50 years—the lar gibbon (*Hylobates lar*) and the northern white-cheeked crested gibbon (*Nomascus leucogenys*) (Fan, Fei and Luo, 2014). There is clear evidence that extant gibbon species occupied a larger range across China in the past and that their current distribution has been affected by human disturbance (Chatterjee, 2009; Chatterjee, Tse and Turvey, 2012; Fan, Fei and Luo, 2014; Li *et al.*, 2018). In addition, new information is coming to light about a gibbon species that went extinct in the last 2,000 years, raising questions about how many other species are waiting to be discovered in the fossil record (Turvey *et al.*, 2018).

A History of Ape Surveys

Surveying Great Apes

For a long time, field survey output on great apes was confined to the production of maps showing locations of occurrence or geographical distributions (Coolidge, 1933; Schouteden, 1930). The limitation was most probably due to the difficulty of observing great apes systematically in dense tropical rainforests, their prime habitat. One of the first attempts to quantitatively estimate the population size and density of a great ape taxon was conducted for mountain gorillas (*Gorilla berengei berengei*) in 1959, but the result suffered from considerable weaknesses (Emlen and Schaller, 1960). Initial survey methods were basic, as scientists attempted to estimate the total population size of a taxon using nest counts of different groups (Plumptre, Sterling and Buckland, 2013).

Photo: All great apes build nests in which they sleep or rest and these nests remain visible for a long time and are therefore much more abundant than the individual apes. © Pascal Goumy (IREB/ KUPRI field assistant)

In the late 1960s, statisticians and field biologists started to develop more reliable quantitative survey methods, which facilitated more accurate estimation of animal population sizes (Plumptre and Cox, 2006). Almost all of these techniques are sample-based, which means that not all individuals of a population need to be counted. Instead, counts are done at selected locations and statistical methods are used to infer total population size. One of these methods—transect sampling—became particularly popular as it permits wildlife statisticians to estimate animal abundance reliably using a set of transects randomly placed across a study area (Plumptre, 2000; Plumptre, Sterling and Buckland, 2013).

In the early 1980s, scientists conducted the first large-scale field surveys on chimpanzees and gorillas in Gabon, using a combination of transect sampling and nest counting, as well as estimation of nest decay time and nest construction rates, to convert the number of nests into the number of apes (Tutin and Fernandez, 1984). This work was the starting point towards the systematic surveying of all great ape taxa. The initial survey method was continuously refined and the methodology, combining ape nest counts with line transect sampling, became the most commonly used approach to estimate ape population density, in view of its robustness and accuracy (Plumptre, Sterling and Buckland, 2013). Since the first large-scale surveys in Gabon, hundreds of field surveys have been conducted using this methodology over extensive areas of ape habitat in Africa and Asia; most of these studies can be found in the A.P.E.S. Portal (IUCN SSC, n.d.-b).

In recent years, developments in genetics, sensor technology and statistics led to a diversification of survey methods that can be applied to surveying great apes. For example, capture–recapture methods use the proportion of individuals identified multiple times or only once during a survey to infer

population size (Arandjelovic *et al.*, 2011; Guschanski *et al.*, 2009; White *et al.*, 1982). Nowadays, scientists use genetic capture–recapture methods—as well as camera traps—for estimating great ape abundance (Arandjelovic and Vigilant, 2018; Després-Einspenner *et al.*, 2017; McCarthy *et al.*, 2018). Capture–recapture methods provide much higher precision and accuracy than counting indirect ape signs, such as nests. Since individuals need to be identified, however, these methods are usually more time-consuming. Capture–recapture is now used in combination with genetic methods for estimating the size of the increasing population of mountain gorillas (Hickey *et al.*, 2019; Roy *et al.*, 2014). Distance sampling with camera trapping has also become a promising approach for surveying great apes (Cappelle *et al.*, 2019).

“The IUCN Section on Small Apes is working on best practice guidelines for surveying and monitoring gibbons to help alleviate some of the many practical, analytical and interpretation issues with gibbon population data.”

Surveying Gibbons

The earliest surveys of gibbons were carried out using transects (Brockelman and Ali, 1987; Carpenter, 1940). Acoustic monitoring was developed in the 1980s and has since been used as the primary survey method for gibbon population surveys (Brockelman and Srikosamatara, 1993; Cheyne *et al.*, 2008, 2016a; Hamard, Cheyne and Nijman, 2010; Nijman and Menken, 2005).[4] For many fragmented gibbon populations, density information is only available from one-off surveys, and there are no long-term trend data or population monitoring, especially for populations outside of protected areas (Cheyne *et al.*, 2016a). Another challenge is estimating populations where group size is not known, and where it is easy to miss non-adult gibbons (Cowlishaw, 1992). The IUCN Section on Small Apes is working on best practice guidelines for surveying and monitoring gibbons to help alleviate some of the many practical, analytical and interpretation issues with gibbon population data (IUCN SSC PSG SSA, n.d.-b).

Future Directions in Data Collection and Analysis

Experts are developing a number of innovative technologies for surveying wildlife, in part aided by the ongoing refinement of equipment for storing and analyzing acoustic data (Corrada Bravo, Álvarez Berríos and Aide, 2017; Xie *et al.*, 2017). The following technologies in particular may allow for more precision in the estimation of population size of ape taxa:

- **Arboreal (canopy) camera traps** (Bowler *et al.*, 2017; Gregory *et al.*, 2014). Camera trapping is now a well-established method of collecting data for wildlife research and conservation, particularly for studying rare and elusive species (Ancrenaz *et al.*, 2014; Cheyne *et al.*, 2013, 2016b, 2018). Until recently, however, such traps were only placed near the ground to study terrestrial species. Using camera traps in the canopy can provide new insight into arboreal activities of gibbons and great apes, as well as many other species.
- **Passive acoustic monitoring** with autonomous recording arrays. Scientists increasingly advocate this type of monitoring in tropical ecosystems as a valuable and cost-effective tool for rapid inventories, as it has been used successfully to detect elusive species in densely forested habitats (Deichmann *et al.*, 2018; Ribeiro, Sugai and Campos-Cerqueira, 2017). In recent years, many researchers have started to use passive acoustic monitoring with audio recording devices, often referred to as autonomous recording units, to collect auditory data related to animal abundance and occupancy (Browning *et al.*, 2017; Heinicke *et al.*, 2015; Kalan *et al.*, 2015, 2016; Mellinger *et al.*, 2007). The method has also been used to facilitate anti-poaching law enforcement (Astaras *et al.*, 2017).

- **Drones carrying acoustic recorders.** Unmanned aerial vehicles, also known as drones, have been employed in several cases to survey great ape nests (Szantoi *et al.*, 2017). Given recent improvements in flight times and the capacity to accommodate payloads—such as lighted cameras and infrared cameras—such vehicles may become increasingly useful for surveying gibbons in remote areas (Alexander *et al.*, 2018). Equipped with acoustic recorders, they could be used to conduct call surveys. The use of drones needs to be explored further before any methods can be recommended for gibbon surveys, however.

Methods for Studying Populations

Population Size Estimates

Methods for Estimating Great Ape Population Sizes

Population abundance figures in this chapter are drawn from peer-reviewed publications, published and unpublished reports, and research and conservation organizations; some are based on guesstimates from experts. Country- and taxon-level estimates were derived using combined estimates from site-level surveys conducted over the past two decades. In this context, sites include protected areas and their buffer zones, unprotected areas, and logging or mining concessions. Additional estimates are based on spatial predictions, which rely on various modeling approaches. These approaches take into consideration key environmental variables that are known to influence ape abundance, such as forest cover, human impact, topography and rainfall; they also factor in the number of nests observed along line transects in previously surveyed areas (Plumptre *et al.*, 2010, 2016c; Strindberg *et al.*, 2018; Voigt *et al.*, 2018; Wich *et al.*, 2016). For mountain gorillas, the genetic capture–recapture method is used to arrive at estimates (Roy *et al.*, 2014).

Surveying populations of great apes and other large mammals is a challenging task since they occur at low densities and visibility in their forested habitat is low (Kouakou, Boesch and Kühl, 2009). Moreover, counting all individuals in their home range is generally not possible over large areas (Reynolds and Reynolds, 1965). Therefore, primatologists count signs of ape presence, such as nests, dung and feeding remains, rather than individual apes themselves (Kühl *et al.*, 2008). The standard method of surveying great ape populations is to count nests along line transects, since all weaned individuals build a new nest to sleep in every night (Fruth, Tagg and Stewart, 2018; Ghiglieri, 1984; Stewart, 2011). Nests remain visible for a long time and are therefore much more abundant than the individual apes.

> “Surveying populations of great apes and other large mammals is a challenging task since they occur at low densities and visibility in their forested habitat is low.”

A large proportion of the survey data used to compute the estimates was collected using systematic line transect distance sampling methods and IUCN best practice guidelines (Buckland *et al.*, 2001, 2007; Kühl *et al.*, 2008). The methods of surveying great apes are described in Kühl *et al.* (2008). They include distance sampling along line transects, but more recently, apes have also been successfully surveyed using camera traps. Cameras can be used as point transects for distance sampling, and to sample images of individuals using spatially explicit capture–recapture methods (Cappelle *et al.*, 2019; Després-Einspenner *et al.*, 2017).

Methods for Estimating Gibbon Population Size

Common methods for surveying gibbons include occupancy modelling, transect walks and fixed-point counts of songs (acoustic

monitoring).[5] If enough surveyors are available, they can use numerous fixed listening posts positioned uniformly over the survey area—for example, 500–800 m apart—for several consecutive days to detect different groups and lone individuals. They can repeat this exercise 2–3 times to confirm that they always detect the same groups and individuals. Next, they can map and triangulate the data to gain a better idea of the gibbons' locations. They can then calculate the density using a formula that takes into account the effective listening area, the calling probability of the gibbons in that survey site and the number of groups heard. The IUCN Section on Small Apes provides sample spreadsheets and a full guide on its website (IUCN SSC PSG SSA, n.d.-a).

Estimating gibbon population size presents a number of challenges. As with surveys of great apes, efforts to count gibbons are typically concentrated in protected areas, while other areas remain unsampled, which can lead to underestimates. Other complications relate to the nature of gibbons, specifically that they are highly mobile, elusive and arboreal. They are difficult to spot due to their preference for the upper canopy and may flee or hide when approached by humans (Nijman, 2001).

Statistical accuracy has improved with the development of new methods, allowing today's practitioners to expect robust research results that can withstand the scrutiny of fellow conservationists, academics, government agencies and the general public. Recent advances in statistical modelling also make possible a reassessment of historical data, which could shed additional light on gibbon population size. Even surveys that are not designed to inform conservation policies or the management of protected areas—including certain classic behavioral studies—may provide useful insights into population size and related data (Bartlett, 2009; Chivers, 1977; Srikosamatara, 1984).

Photo: Gibbons are highly-mobile, cryptic, arboreal species and this raises challenges for surveying and monitoring. © Kike Arnal/ Arcus Foundation

Population Trends

Great Apes

Population trends presented in this chapter were determined using various modeling approaches, based on nest data for sites where at least two surveys for two different time periods were available, or on a compilation of taxon-specific abundance information from available survey reports and peer-reviewed literature. All of this information was extracted from the A.P.E.S. database (IUCN SSC, n.d.-a). Arriving at rate-of-change estimates involved modeling the impact of time on ape nest encounter rates. The change in these rates, between two time periods, served as a proxy for ape population change (Kühl *et al.*, 2017; Plumptre *et al.*, 2015, 2016c; Strindberg *et al.*, 2018; Voigt *et al.*, 2018). Trends for the Tapanuli orangutans were based on different land cover and land use scenarios (Wich *et al.*, 2016).

Gibbons

For each taxon, trend data were obtained by assessing the number of individuals remaining, the decline over time, the area of habitat occupied by the species and the level of threats. As noted above, threats vary within species, particularly among the ones that cross international boundaries. Since 19 of the 20 species of gibbon are threatened, there is an urgent need to obtain accurate data on population size and density, primarily to allow practitioners to monitor trends and inform conservation actions, strategies and policies at all scales —from individual sites and protected areas to countries and regions. Estimates of gibbon population density and abundance are an essential component of conservation action because they reflect the extent and impact of threats as well as the efficacy of actions taken to combat them. Without such monitoring data, it is not possible to know whether efforts to conserve the world's gibbons are successful.

Population and Conservation Status of Apes

Taxon-Level Ape Abundance

African Great Ape Taxon-Level Estimates

Great apes are scattered across 21 African countries. They comprise nine taxa distributed among four species (see Table 7.1). With an estimated 350,000 or more individuals in the wild, the western lowland gorilla is the most abundant great ape taxon; in stark contrast, the Cross River gorilla has the smallest population, comprising fewer than 300 mature individuals. The current population figures for the western lowland gorilla, central chimpanzee and western chimpanzee are higher than they were about 20 years ago, not because of population increases, but rather as a result of more wide-ranging survey efforts (see Table 7.3).

Asian Great Ape Taxon-Level Estimates

Orangutans are found only on the islands of Sumatra and Borneo, in Indonesia and Malaysia (Wich *et al.*, 2008). They comprise three species distributed across five taxa: the three subspecies of Bornean orangutan (*Pongo pygmaeus*)—the Northeast Bornean orangutan (*Pongo p. morio*), Northwest Bornean orangutan (*Pongo p. pygmaeus*) and Southwest Bornean orangutan (*Pongo p. wurmbii*)—the Sumatran orangutan (*Pongo abelii*) and the Tapanuli orangutan (*Pongo tapanuliensis*) (Nater *et al.*, 2017). All are critically endangered.

Table 7.4 presents current population sizes for all orangutan taxa. Recent estimates for the Bornean orangutan and the Sumatran orangutan are higher than they were 15 years ago, largely due to improved survey techniques and coverage, which provide more

TABLE 7.3

African Great Ape Population Estimates and Status, in Descending Order of Abundance

Taxon	1989–2000		2018		
	Abundance	IUCN status	Abundance	IUCN status	Source
Western lowland gorilla *Gorilla gorilla gorilla*	94,500	Endangered	316,000*	Critically endangered	Strindberg *et al.* (2018)
Eastern chimpanzee *Pan troglodytes schweinfurthii*	75,200–117,700	Endangered	181,000–256,000	Endangered	Plumptre *et al.* (2010, 2016a)
Central chimpanzee *Pan t. troglodytes*	47,500–78,000	Endangered	128,760 (114,208–317,039)	Endangered	Strindberg *et al.* (2018)
Western chimpanzee *Pan t. verus*	25,500–52,900	Endangered	18,000–65,000	Critically endangered	Humle *et al.* (2016); Kühl *et al.* (2017)
Bonobo *Pan paniscus*	35,000	Endangered	15,000–20,000 minimum	Endangered	IUCN and ICCN (2012)
Grauer's gorilla *Gorilla beringei graueri*	16,900	Endangered	3,800 (1,280–9,050)	Critically endangered	Plumptre *et al.* (2015, 2016c)
Nigeria–Cameroon chimpanzee *Pan t. ellioti*	4,000–6,000	Endangered	4,400–9,345	Endangered	Mitchell *et al.* (2015); Morgan *et al.* (2011); Oates *et al.* (2016)
Mountain gorilla *Gorilla b. beringei*	324	Critically endangered	>1,000	Endangered	Hickey *et al.* (2019)
Cross River gorilla *Gorilla g. diehli*	200	Critically endangered	<300	Critically endangered	Bergl *et al.* (2016); Dunn *et al.* (2014); R. Bergl and J. Oates, personal communica-tion, 2018

Notes: Abundance estimates for mountain gorillas include infants; all other estimates represent the number of weaned individuals capable of building nests. Estimates are derived from surveys and modelling approaches.

* Based on an estimate of 361,919 (302,973–460,093) for 2013 and an annual rate of decline of 2.7%.

Sources: population estimate 1989–2000: Butynski (2001); population estimate 2018: GRASP and IUCN (2018, table 3)

TABLE 7.4

Asian Great Ape Population Past and Recent Estimates, in Descending Order of Abundance

Taxon	Abundance	Survey period	Abundance	Survey period	Source
Southwest Bornean orangutan *Pongo p. wurmbii*	>34,975	2002	97,000 (73,800–135,000)	1999–2015	Voigt *et al.* (2018)
Northeast Bornean orangutan *Pongo p. morio*	15,842 (8,317–18,376)	2002	30,900 (22,800–44,200)	1999–2015	Voigt *et al.* (2018)
Sumatran orangutan *Pongo abelii*	12,000*	1996	13,900 (5,400–26,100)	2016	Wich *et al.* (2016)
Northwest Bornean orangutan *Pongo pygmaeus pygmaeus*	1,143–1,761	2002	6,300 (4,700–8,600)	1999–2015	Voigt *et al.* (2018)
Tapanuli orangutan *Pongo tapanuliensis*	n/a*	1996	767 (231–1,597)	2000–12	Nowak *et al.* (2017); Wich *et al.* (2019)

Notes: * The Sumatran and Tapanuli orangutans were treated as the same species until 2017. All orangutan taxa are critically endangered.

Sources: 1996: Rijksen and Meijaard (1999); 2002: Wich et al. (2008); 2016 and 2018: GRASP and IUCN (2018, table 7) accurate data for predictions (GRASP and IUCN, 2018; Voigt *et al.*, 2018; Wich *et al.*, 2016). Tapanuli orangutans were studied as a distinct taxon for the first time in 2017 (Nater *et al.*, 2017). Prior to that, they were thought to be a population of the Sumatran orangutan.

Gibbon Taxon-Level Estimates

Taxonomic studies and surveys indicate that gibbon populations are in decline, more and more fragmented and isolated, and at increasing risk of local extinction (Fan *et al.*, 2017). There is a dearth of data for some species, such as the Gaoligong hoolock (*Hoolock tianxing*) population, some of which occurs in an area of Myanmar that is experiencing severe civil unrest (Fauna and Flora International Myanmar, personal communication, 2018). Conservation measures are urgently required to prevent small, isolated gibbon populations from declining further. An estimated 300 Gaoligong hoolocks in nine locations and all 34 Hainan gibbons (*Nomascus hainanus*) in one location are among at-risk populations whose numbers are already critically low (Fan P.-F., personal communication, 2018).

The Bornean white-bearded gibbon (*Hylobates albibarbis*)—with a population of about 120,000 individuals—Müller's gibbon (*Hylobates muelleri*), the pileated gibbon (*Hylobates pileatus*) and the siamang (*Symphalangus syndactylus*) are the most numerous taxa (see Table 7.5). An estimated 60% of large gibbon populations tend to be found outside protected areas (Cheyne *et al.*, 2016a; Guan *et al.*, 2018).

Country-Level Ape Abundance

African Great Apes

The population sizes of bonobos, chimpanzees and gorillas vary greatly across African range countries. Almost 95% of all African great apes occur in five countries; in the order of abundance, they are the Republic of Congo, the Democratic Republic of Congo (DRC), Gabon, Cameroon and Guinea. The Republic of Congo and the DRC alone host more than 50% of the cumulative population of all nine great ape taxa. The DRC is home to the greatest number of taxa (five), followed by Cameroon (four). Burundi, Ghana, Mali, Rwanda and Senegal only host a few hundred great apes (see Annex IV).

Asian Great Apes

Far more orangutans live in Indonesia than in Malaysia. The former hosts about 141,700 individuals, while the latter is home to just over 12,000 (see Annex V).

Gibbons

Gibbons exhibit great taxonomic diversity and variations in population size across the 11 countries where they occur. The estimated cumulative population size for the 20 taxa is about 600,000 individuals. Indonesia alone hosts 9 of the 20 taxa and a cumulative population of more than 330,000 individuals; Malaysia follows with 4 taxa and 100,000 individuals; then come Myanmar (with 3 taxa and more than 55,000), Thailand (with 2 taxa and 45,000) and Cambodia (with 2 taxa and 40,000). Bangladesh is home to only one taxon—the western hoolock—whose population hovers around 200 (see Annex VI).

Population Trends

Population trends and the annual rate of population change vary across ape taxa. Of all great apes and gibbons, only the mountain gorillas are increasing in number.

African Great Apes

As noted above, apart from the mountain gorillas, all great ape taxa in Africa are

TABLE 7.5

Gibbon Population Estimates and Status, in Descending Order of Abundance

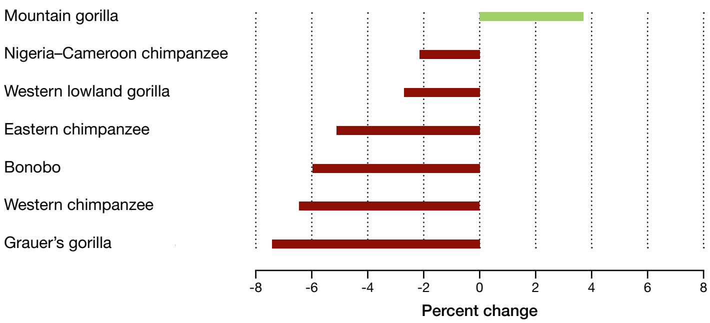
Taxon	Abundance	IUCN status
Bornean white-bearded gibbon *Hylobates albibarbis*	120,000	Endangered
Müller's gibbon *Hylobates muelleri*	100,000	Endangered
Pileated gibbon *Hylobates pileatus*	60,000	Endangered
Siamang *Symphalangus syndactylus*	60,000	Endangered
Moloch gibbon *Hylobates moloch*	48,500	Endangered
Gaoligong hoolock *Hoolock tianxing*	40,000	Critically endangered
Agile gibbon *Hylobates agilis*	25,000	Endangered
Kloss's gibbon *Hylobates klossii*	25,000	Endangered
Lar gibbon *Hylobates lar*	25,000	Endangered
Western hoolock *Hoolock hoolock*	15,000	Endangered
Bornean gray gibbon *Hylobates funereus*	10,000	Endangered
Eastern hoolock *Hoolock leuconedys*	10,000	Vulnerable
Southern yellow-cheeked crested gibbon Nomascus gabriellae	8,000	Endangered
Northern yellow-cheeked crested gibbon *Nomascus annamensis*	6,500	Endangered
Southern white-cheeked crested gibbon *Nomascus siki*	6,000	Critically endangered
Western black crested gibbon *Nomascus concolor*	5,350	Critically endangered
Northern white-cheeked crested gibbon *Nomascus leucogenys*	2,000	Critically endangered
Cao Vit gibbon *Nomascus nasutus*	229	Critically endangered
Hainan gibbon *Nomascus hainanus*	34	Critically endangered
Abbott's gray gibbon *Hylobates abbottii*	n/a	Endangered

Notes: Estimates are based on the number of duetting or singing adults and thus exclude subadults, juveniles and infants. Estimates are derived from surveys and modelling approaches.

Source: unpublished IUCN Red List updates, seen by the authors, 2019 (now published in: Brockelman and Geissmann, 2019, 2020; Brockelman *et al.*, 2020; Brockelman, Molur and Geissmann, 2019; Cheyne and Nijman, 2020; Fan, Turvey and Bryant, 2020; Geissmann and Bleisch, 2020; Geissmann *et al.*, 2020; Liswanto *et al.*, 2020; Marshall, Nijman and Cheyne, 2020a, 2020b; Nguyen *et al.*, 2020; Nijman, 2020; Nijman, Cheyne and Traeholt, 2020; Nijman *et al.*, 2020; Pengfei *et al.*, 2020; Rawson *et al.*, 2020a, 2020b, 2020c; Thinh *et al.*, 2020)

FIGURE 7.1

Annual Population Change among African Great Apes, by Taxon



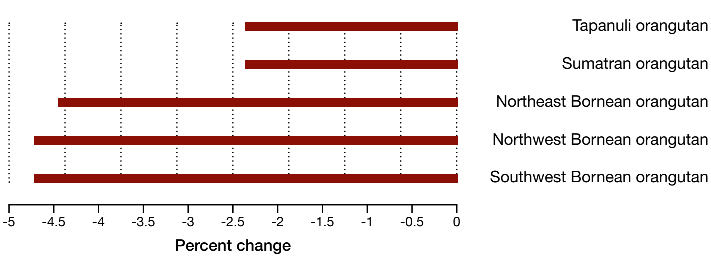
Note: For more details, see Annex VII.

Source: GRASP and IUCN (2018, table 4)

decreasing. Between 1994 and 2015, the Grauer's gorilla population declined by 7.4% per year, dropping from 16,900 to 3,800 individuals (Plumptre *et al.*, 2015, 2016c). The second largest drop was that of the western chimpanzee, whose numbers declined by 6.5% per year, with the result that their population shrank by 80.2% between 1990 and 2014 (Kühl *et al.*, 2017). In contrast, mountain gorillas experienced a growth rate of 3.7% per year between 2003 and 2010 (Gray *et al.*, 2013). The decline of the central chimpanzee between 2005 and 2013 was not statistically significant (Strindberg *et al.*, 2018). Given the extent of poaching throughout Central Africa, however, conservationists indicate that this taxon is probably experiencing a decline that the current modeling approaches cannot detect (Maisels *et al.*, 2016). Figure 7.1 and Annex VII present an overview of the population trends in all African great apes.

FIGURE 7.2

Annual Population Change among Asian Great Apes, by Taxon



Note: For more details, see Annex VIII.

Source: GRASP and IUCN (2018, table 4)

Asian Great Apes

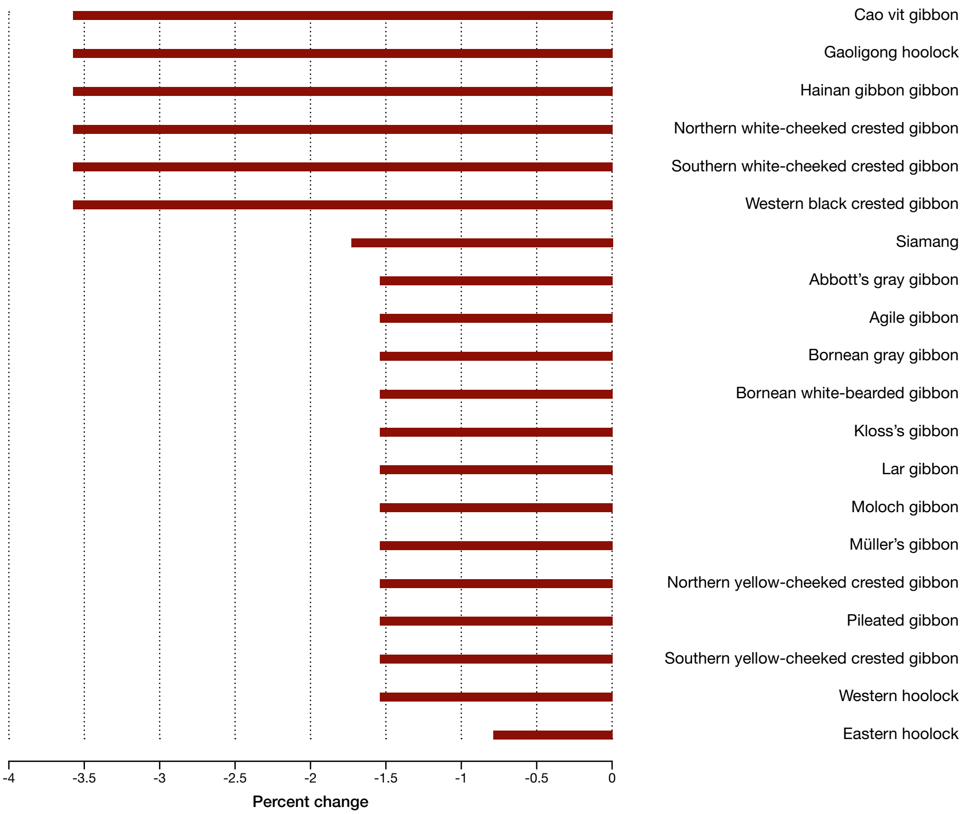
The populations of all orangutan taxa are experiencing drastic declines. The Bornean orangutan population decreased by more than 50% between 1999 and 2015; the 1999 population numbers may drop by as much as 81% by 2080 if current land cover changes continue (GRASP and IUCN, 2018; Wich *et al.*, 2015). Sumatran orangutans are expected to lose more than 30% of their current population by 2030, if the current deforestation rate continues (Wich *et al.*, 2016). The data also indicate that, by 2060, the Tapanuli orangutan population will have declined by an estimated 83% compared to 1985 levels[6] (GRASP and IUCN, 2018; Nowak *et al.*, 2017). Figure 7.2 and Annex VIII present a synthesis of the population trends in orangutans.

Gibbons

For each taxon, trend data were obtained from experts at the IUCN Red List assessment workshop held at the Singapore Zoo in November 2015 (ZOO, 2015). Collected information includes data on the number of individuals remaining, the decline over time, the area of habitat occupied by a species and the levels of threats. All gibbons are experiencing steep population declines; since 1985, 19 of the 20 taxa have lost 50–80% of their populations (see Figure 7.3 and Annex IX). Taxa with tiny populations—such as the Hainan gibbon (34 individuals left) and the Cao Vit gibbon (129 individuals remaining in China and 100 in Viet Nam)—may go extinct within a few years.

FIGURE 7.3

Annual Population Change among Gibbons, by Taxon



Notes: For details on survey periods, see Annex IX.

A number of taxa experienced similar levels of decline over the 45 year survey period, resulting in the same annual rate of change.

Sources: unpublished IUCN Red List updates, seen by the authors, 2019 (now published in: Brockelman and Geissmann, 2019, 2020; Brockelman *et al*., 2020; Brockelman, Molur and Geissmann, 2019; Cheyne and Nijman, 2020; Fan, Turvey and Bryant, 2020; Geissmann and Bleisch, 2020; Geissmann *et al*., 2020; Liswanto *et al*., 2020; Marshall, Nijman and Cheyne, 2020a, 2020b; Nguyen *et al*., 2020; Nijman, 2020; Nijman, Cheyne and Traeholt, 2020; Nijman *et al*., 2020; Pengfei *et al*., 2020; Rawson *et al*., 2020a, 2020b, 2020c; Thinh *et al*., 2020)

Conclusions on Ape Status

Great Apes

As discussed above, the process of assessing the status of ape populations has its roots in the 19th century, when scientists started collecting specimens for museums as part of their efforts to map ape presence. Since then, the development of various survey techniques—from distance sampling to advanced genetic, camera-trapping and statistical methods—has allowed for the surveying of vast areas across ape ranges. The A.P.E.S. database team is working with researchers and conservationists worldwide to identify, compile, update and archive all available ape survey data in a central repository, so as to facilitate reliable population estimates for all great ape taxa (IUCN SSC, n.d.-a). Available data now permit researchers to estimate the number of apes left in the wild, which was still a mystery just a few decades ago. The data indicate that:

- African habitats harbour about 730,000 great apes; and
- Asian forests are home to about 150,000 orangutans, more than 80% of whom are Bornean orangutans.

These figures—combined with the population trend data presented above and in the annexes of this chapter—underscore the urgent need for evidence-based evaluations of conservation efforts. Only through evaluations can the most effective approaches be identified and strengthened. Surveys and biomonitoring provide critical data for such evaluations, as they allow for assessments of the impacts of different approaches and tools, such as protected areas, resource management and land use schemes. When evaluation results are fed back into the redesign of conservation approaches, they can contribute to reducing the rate of decline of great ape populations.

Gibbons

Given the high rate of gibbon population decline, accurate and current data on density and abundance are urgently required so that trends may be identified and tracked. While comprehensive surveys have yet to be undertaken for many taxa, available data indicate that about 600,000 gibbons remain in the wild; the Bornean white-bearded gibbon makes up 25% of this figure. As noted above, the A.P.E.S. database is currently being expanded to cover population survey data on gibbons as well as great apes, which will enable more refined estimates for all ape taxa. Moreover, the accuracy and utility of gibbon survey and monitoring methods is likely to increase once the IUCN Section on Small Apes releases best practice guidelines.

Mitigating the threats facing gibbons throughout their ranges requires intensive, well-planned conservation actions at all scales—from individual sites and protected areas to national and regional action plans, strategies and policy initiatives. Estimates of gibbon population density and abundance are an essential component of conservation action because they reflect the extent and impact of threats and the efficacy of actions taken to combat them. Without such biomonitoring data it is not possible to know whether conservation practices are succeeding in protecting the world's gibbons.

Urgent conservation interventions are needed to prevent small, isolated populations—such as those of the Cao Vit gibbon and Gaoligong gibbon—from reaching critically low numbers. Displaced and orphaned apes in rescue centers could potentially contribute to restoring viable populations in areas where apes have been extirpated, so long as threats can be mitigated in those locations. Since these apes are legally protected and endangered throughout their range, it can be argued that there is a legal obligation to care for them (Campbell, Cheyne and Rawson, 2015).

Evidence-Based Conservation

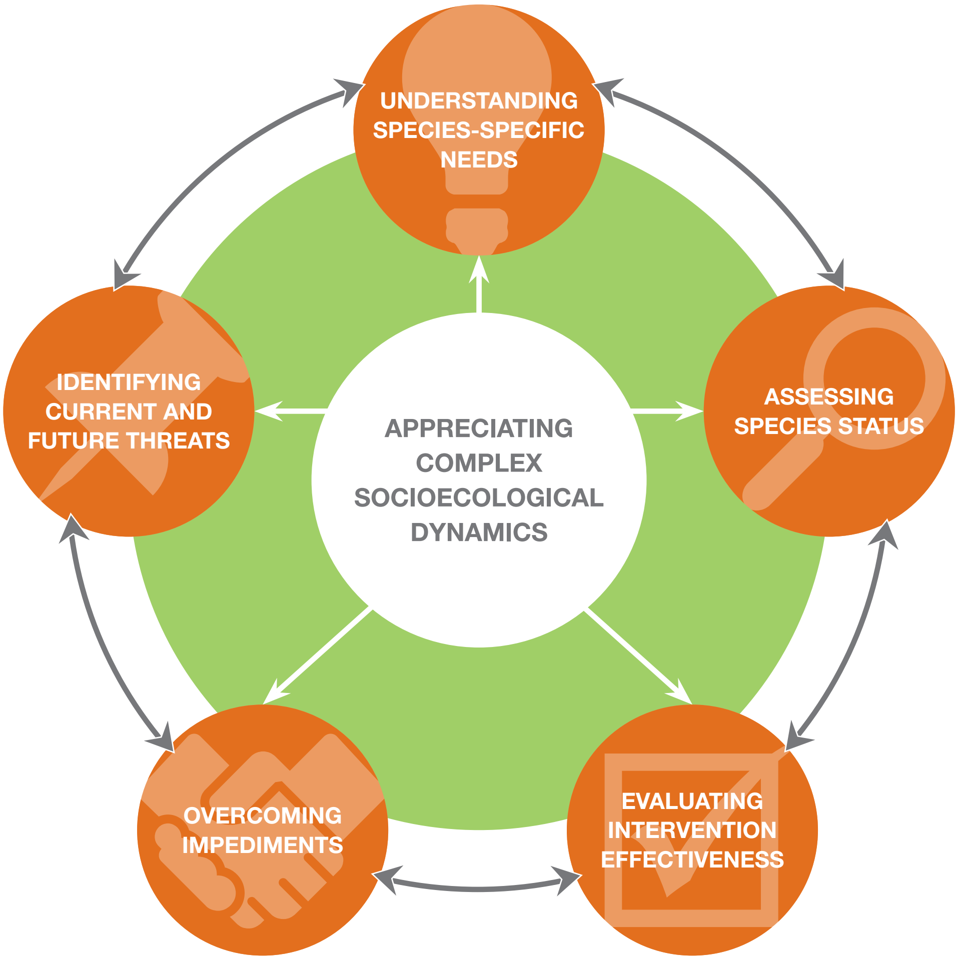
The Basics

For species conservation to be effective, a good understanding of the following issues is fundamental:

- species-specific needs in terms of habitat, environmental and socio-demographic requirements;
- the threats to the survival of the species and underlying drivers of those threats;
- the status of the species in terms of spatial distribution, abundance, population units and population change over time;
- ongoing conservation interventions and their effectiveness; and
- the social, economic and political factors that prevent or enable effective protection (Sutherland, 2009; see Figure 7.4).

FIGURE 7.4

Building an Understanding of Complex Socioecological Systems in Ape Habitats



Historically, conservation was based on models established during colonial times. They tended to promote the protection of nature through national parks for reasons that were based largely on particular interests, such as to enable hunting or to preserve aesthetically pleasing landscapes or species. As a result, reserve systems throughout the world contain a biased sample of biodiversity, usually that of remote places and other areas that are unsuitable for commercial activities (Margules and Pressey, 2000). Even in the more recent past, many species conservation approaches have been based on individual experience, traditional approaches and anecdotal information. These interventions have been based on assumptions about impact and effectiveness, rather than on comprehensively designed frameworks and conservation strategies (Neugebauer, 2018). Practitioners have not made systematic use of social, economic or ecological data to inform the design of conservation responses. Nor have they methodically evaluated the effectiveness of conservation activities or shared assessments in the public domain (McKinnon *et al.*, 2015).

The first evidence-based conservation target to be specified in the literature was published in 1970 (Odum, 1970). Another three decades would pass before scientists began to employ methodical assessments of evidence as a way of furthering species conservation. A prominent example of such work is the Conservation Measures Partnership, which led to the Open Standards for the Practice of Conservation in 2004 (CMP, n.d.-a). Several scientific journals—such as *Conservation Evidence* and *Conservation Science and Practice*—also promote applied conservation knowledge. They report on the experience of researchers and conservationists who have attempted to take a systematic approach to measuring the impact of different conservation initiatives (Sutherland *et al.*, 2004; Odum, 1970, cited in Svancara *et al.*, 2005).

While the past two decades have witnessed concerted efforts to define evidence-based approaches to conservation, uptake and implementation remain limited (Junker *et al.*, 2017). The lack of enthusiasm reflects the fact that it is difficult to evaluate responses to conservation needs, which are typically complex in nature. In addition, publishing effectiveness evaluations for conservation actions can be time- and resource-intensive. If evaluations reveal that a conservation action was not effective, relevant findings may be buried in reports that do not undergo peer review and may thus remain largely unknown and inaccessible (Junker *et al.*, in press).

Conservation frameworks can inform the design of effective context-specific strategies; they can also help practitioners to overcome the institutional, social, economic and political impediments that may prevent progress towards long-lasting species conservation (Hill *et al.*, 2015). Following on from the development and implementation of a conservation framework, an essential element of evidence-based conservation is adaptive management. This stage involves ongoing monitoring and evaluation through the collection and analysis of data; it covers the entire conservation process, which ultimately results in evidence-informed outcomes (see Figure 7.5). Ongoing monitoring of outcomes yields information that can guide the adjustment of approaches, so long as these remain flexible.

Types of Evidence

Through evidence-based conservation, practitioners look to improve the scientific basis of their work as well as their management practices. In essence, this approach involves building an evidence base and responding to it. Evidence from research, action planning and management practices is available in many different forms, including:

- **Peer-reviewed scientific journals:** To ensure a high standard of quality, panels of experts evaluate articles before they are published in these journals.
- **Expert understanding:** Scientists build up a wealth of knowledge through field studies and desk research, as do those working for conservation organizations and other civil society stakeholders, among others. The knowledge and understanding provided by these individuals can be a valuable addition to available research, especially with respect to complex habitats.
- **Gray literature:** This broad term refers to information that has not been formally published. It includes internal research and reports from non-governmental organizations (NGOs), policy institutes and think tanks; conference proceedings; government reports, policy documents and working papers; monitoring and evaluation reports; technical reports; and theses and dissertations (Haddaway and Bayliss, 2015).

FIGURE 7.5

Conservation Cycle for Project Planning, Management, Monitoring, Adaptation and Sharing

Reproduced from: CMP (2013, p. 5)

- **Indigenous knowledge:** There is growing recognition that indigenous and local knowledge can, and should, inform science and management planning to enhance the effectiveness of interventions (Raymond *et al.*, 2010).

Using an Evidence-Based Conservation Framework for Apes

An effective conservation strategy for widely distributed species, such as many ape taxa, has the following components: species protection; site/habitat conservation and management; and conservation and management in the wider landscape (such as outside protected areas or within industrial concessions). Each site has a specific cultural, political, social and economic context that not only bears influence on threats to apes, but also on how those threats affect the species and the habitat. Although conservationists generally understand broad threats, they tend to have an incomplete awareness of the complex dynamics at play in local socioecological systems; the effectiveness

TABLE 7.6

Examples of Challenges to Conservation

Category	Challenge	Example
Social	Cultural preferences	■ Great ape meat is prized among some urban communities, leading to targeted commercial hunting (Tagg *et al.*, 2018). ■ Some traditional communities depend heavily on hunting and the harvesting of natural resources (Caniago and Stephen, 1998; Loibooki *et al.*, 2002).*
Economic	Conservation costs borne mainly locally	■ Local communities bear a disproportionate share of the costs of ape conservation (Green *et al.*, 2018).
	Economic targets outweigh conservation goals	■ When economic development clashes with conservation goals, the former is generally given priority, particularly in developing countries, where vast segments of the population live in poverty (Kormos *et al.*, 2014).
	Poverty	■ In range states, which are among the poorest in the world, many people depend on the harvesting of natural resources as a primary source of food or income. Under some circumstances, the result can be unsustainable use (Gadgil, Berkes and Folke, 1993).
	Increasing resource demand	■ Human population growth is generally high (about 3%) in African range states, which can lead to increases in levels of commercialized hunting and unsustainable use of natural resources, including endangered species (World Population Review, 2019).
		■ Demand for timber, minerals and other natural resources continues to drive road expansion into remote forest areas (IUCN, 2014; Kormos *et al.*, 2014).
		■ Increasing global demand for resources may lead to falling food imports to range states and result in further agricultural expansion into ape habitat (FAO, 2017).
Institutional	Lack of inclusion	■ Many conservation efforts use top–down approaches (Brechin and West, 1990). As a result, conservation planning and implementation often exclude indigenous and other local communities, inhibit the traditional use of natural resources and fail to incorporate valuable indigenous knowledge and traditional conservation practices (Becker and Ghimire, 2003).

of conservation interventions, policies and strategies; and the institutional, social, political and economic challenges to species conservation (see Table 7.6).

Ape species also vary significantly in their socioecology, demography and behavior, which has implications for their conservation and means that commonly used conservation approaches—such as co-use of areas by humans and apes—are not always viable for apes (Hockings *et al.*, 2015; Woodford, Butynski and Karesh, 2002). Unlike many other species, great apes are large-bodied, have slow life histories and exhibit low reproductive rates, such that the loss of even a few individuals has severe consequences for the persistence of populations (Duvall, 2008; Duvall and Smith, 2005; Marshall *et al.*, 2016; Wich, de Vries and Ancrenaz, 2009). Consequently, common conservation strategies that are applied for other species, including ones that feature sustainable offtake rates, are not viable options for apes (Covey and McGraw, 2014; Noutcha, Nzeako and Okiwelu, 2017).

Ape conservation practice often requires immediate action, leaving little time and resources for a systematic assessment. The

Category	Challenge	Example
	Insecure land tenure	■ Most ape range countries have insecure land tenure systems (Robinson *et al.*, 2018). Without tenure security, it can be difficult to encourage long-term, sustainable investments, such as soil conservation and tree planting (Holden, Deininger and Ghebru, 2009).
	Corruption	■ Government corruption is associated with poor environmental performance (Peh and Drori, 2010).
Strategic	Poor implementation of conservation activities outside protected areas	■ Efforts to incentivize the promotion of sustainably certified products are insufficient, especially in Asian markets (Meijaard *et al.*, 2012; Mishra *et al.*, 2003; Swarna Nantha and Tisdell, 2009).
		■ Regulation of concessions to protect apes is often ineffective (Morgan and Sanz, 2007).
	Mismatch in time scales	■ Time lags between conservation planning, implementation and tangible outcomes render investment in ape conservation uncertain and reduce the motivation of funding agencies.
	Lack of dedicated long-term funding	■ Conservation projects generally receive short-term funding, but ape conservation needs more stable investment due to the complexity and long-term nature of the issues to be addressed (Tranquilli *et al.*, 2012).
	Lack of information	■ Few policymakers and conservation practitioners have access to (translated) scientific publications or evidence that could influence their management choices (Karam-Gemael *et al.*, 2018).
Capacity	Ineffective law enforcement	■ Weak capacity in law enforcement may reflect limited knowledge, skill, staffing or equipment.
		■ Corruption and weak regulatory systems contribute to wildlife trafficking (Wyatt *et al.*, 2018).
	Lack of baselines and continuous monitoring	■ Rigorous impact evaluation studies are lacking (Ferraro and Pressey, 2015; McKinnon *et al.*, 2015).
		■ Ape population estimates are generally imprecise (Kühl *et al.*, 2008).

Note: * A thorough understanding of local cultural practices is critical to ensure that not all traditional communities are categorized as hostile to conservation goals; some communities explicitly protect habitats and species, thereby facilitating the sustainable management of ecosystems (Gadgil, Berkes and Folke, 1993; Heinicke et al., 2019; Stevens, 1997).

success rate of such interventions can be maximized if an evidence-based framework and strategies are already in place (Heinicke *et al.*, 2019). Indeed, broad uptake of evidence-based conservation would build on, and contribute to, existing ape action plans (IUCN SSC PSG, n.d.). An example of evidence-based conservation practice is provided in Case Study 7.1.

Apes, and particularly great apes, receive considerable attention from the general public, conservation initiatives and the private sector, and thus serve as flagship and umbrella species for the protection of biodiversity (Hassan, Scholes and Ash, 2005; Wrangham *et al.*, 2008). Due to this interest, they are among the most closely monitored taxonomic groups; by keeping a close watch on them, organizations such as IUCN, GRASP and a broad spectrum of NGOs facilitate consistent updating of status and trend assessments (Heinicke *et al.*, 2019). Compared to most other species, apes are thus relatively well placed candidates for an evidenced-based conservation framework, given that the necessary data, will, interest and funding are more readily available (Robbins *et al.*, 2011).

Integrating Evidence into Conservation

The successful integration of evidence into the conservation process—from development to implementation and throughout adaptive management—relies on the collection and sharing of relevant, high-quality data, in particular through:

- **appropriate research design** that sets out best practice for rigorous testing of interventions, reporting on effectiveness, and standards of implementation, ideally as applied to research that focuses on conservation priorities and needs;
- **increased sharing of data and findings** from conservation research, practice and assessment among all stakeholders—including conservation practitioners, researchers, NGOs, governments and the private sector—in a way that is accessible to all, including through translations into relevant languages; and
- **databases of references, summaries of findings and systematic reviews**, including gray literature, to enable easy identification of relevant evidence for use in planning and decision-making.

Two examples of initiatives that are designed to integrate evidence into conservation are the Conservation Evidence Project and the Open Standards for the Practice of Conservation.

The Conservation Evidence project website was established as a central hub for evidence regarding conservation actions and their effectiveness. It is an open access, user-friendly tool that aims to facilitate decision-making by compiling field studies on different taxa, including apes (Conservation Evidence, n.d.-a; Junker *et al.*, 2017; Petrovan *et al.*, 2018). Conservation Evidence produced the free PRISM toolkit, which can help practitioners design robust studies to test interventions and report effectiveness results (Dickson *et al.*, 2017; PRISM, n.d.). The project also started an initiative called Evidence Champions, designed to motivate companies, organizations, institutions, journals and individuals not only to increase the use of conservation evidence in project planning, but also to test interventions, publish results, provide weblinks to Conservation Evidence, and use the Conservation Evidence database as a tool for the submission of studies for publication (Conservation Evidence, n.d.-b).

The Open Standards for the Practice of Conservation website assembles guidance, tools, case studies and complementary materials from more than 600 organizations to facilitate systematic planning, implementation and monitoring of conservation initiatives (CMP, n.d.-b).

Horizon Scanning

Horizon scanning is an exercise that identifies and assesses emerging developments, opportunities and threats (Sutherland and Woodroof, 2009). It allows scientists and conservationists to undertake timely research and inform decision-makers about pressing issues and consequences of associated policies and practices. Conservationists have been using horizon scanning for more than a decade (Sutherland *et al.*, 2019b; Sutherland and Woodroof, 2009). The technique has gained traction as it allows for the anticipation and mitigation of threats that could otherwise go unnoticed, such that regular horizon scanning exercises are now undertaken to increase preparedness and capitalize on opportunities (Sutherland *et al.*, 2019b).

In the absence of horizon scanning, threats to apes can develop without adequate input from conservation researchers, practitioners and policymakers. The environmental consequences of the policy-driven switch from fossil to bio fuel, for example, received insufficient consideration (Sutherland and

CASE STUDY 7.1

Evidence-Based Conservation Practice: Targeting Wild Meat in Eastern Democratic Republic of Congo

In recent years, a consortium has emerged to conserve the entire population of Grauer's gorillas and significant numbers of chimpanzees in eastern Democratic Republic of Congo (DRC) (JGI, n.d.). Known as Ushiriki (which means "union" in Kiswahili), the consortium brings together more than 20 actors, signalling a shift from individual to collective, evidence-based planning and actions across a landscape of 268,800 km² (2.7 million ha) identified in an IUCN-validated conservation action plan (CAP) (Maldonado *et al*., 2012). The Ushiriki Consortium includes local, national and international NGOs, national and provincial representatives of the Congolese Ministry of Environment and Sustainable Development, and provincial and site-based representatives of the national nature conservation agency, the Institut Congolais pour la Conservation de la Nature.

A four-body coordination mechanism within the Ushiriki Consortium facilitates collaboration and adaptive management. The revision of the strategic framework and theories of change, as well as the prioritization of activities, are based on increasingly nuanced contextual and collective knowledge. In 2018, the consortium identified the need to add a wild meat committee to address knowledge gaps, such as the lack of baseline data on hunting, commerce and consumption of wild meat across the landscape. The committee also encourages partners to harmonize best practice approaches for behavior change. Based on emerging evidence and responses to focused research questions, the consortium develops best practices that can be applied in addressing stakeholders and their activities within the commercial wild meat value chain. Current shortcomings in this model revolve around data sharing and access. The consortium is therefore discussing how best to ensure access to the evidence—in the form of data, information, knowledge or wisdom—through an information-sharing platform and internal database (Salafsky *et al*., 2019).

Focused Research Design

The Community Conservation Zone of Lubutu and Walikale Territories

The CAP proposes a range of broad hypotheses; individual actors of the Ushiriki Consortium render these hypotheses specific and make them operational at the site level. The successful application of evidence-based decision-making to the wild meat trade is possible only if the scope of analysis is broadened from the site level to include the entire value chain.

Figure 7.6 (overleaf) shows the community conservation zone of Lubutu and Walikale Territories (CoCoLuWa) as a management unit comprising village networks and conservation sites that constitute a regional wild meat value chain. An understanding of the dynamics of this—or any other—management unit calls for an appreciation of the local ecology as well as social, economic and political nuances. The CoCoLuWa management unit, which occupies the community conservation corridor between Maiko and Kahuzi-Biega National Parks, is dominated by dense, humid, lowland forests with subalpine and seasonally inundated gallery forests in the eastern limits. The area harbors more than 20 flagship species, including endangered and endemic species, such as Grauer's gorilla.

Human activity in CoCoLuWa forests is evident through the presence of metal cable and nylon cords that are used for traps; empty cartridges; active and abandoned hunting, fishing and mining camps; and signs of non-timber forest product collection. Violent conflict in the management unit most often involves armed groups that seek to control resources, such as artisanal mining camps. Additional challenges to conservation include a lack of access to the region, which results in isolation and compromises access to markets.

Acquiring Baseline Data with Local Actors

Previous interventions attempted to mitigate threats by supporting the enforcement of laws on illegal hunting and wildlife trade, stakeholder education and awareness raising of laws and protected species, and protein replacement for wild meat. Due to a lack of baseline data, initiatives that promoted wild meat alternatives were not designed using evidence-based decision-making, nor was their impact properly assessed. Failure in these cases was indicated by a lack of uptake by the population.

In the CoCoLuWa management unit, the Ushiriki Consortium thus prioritized bridging the knowledge gap on baselines of killing and consumption of wild meat, specifically by fostering the involvement of local actors using dedicated funding. Local actors who implement priority activities of the CAP may be integrated into the consortium.

Behavior Change Best Practice

Current activities that seek to reduce the demand for wild meat include focused research on current livelihoods and the social, political and economic drivers for local participation in the commercial wild meat trade. The data are being used to inform a behavior change campaign. The revised CAP captures behavior change in new objectives, indicators and activities, as an evolution from awareness raising.

Asked what they consider the main obstacles to sustainable livelihoods, 70% of CoCoLuWa residents identified poverty—or, more specifically, a lack of financial means to invest in developing new activities—and 29% cited low agricultural productivity. More than two-thirds of the population (76%)

FIGURE 7.6

CoCoLuWa Conservation Zone

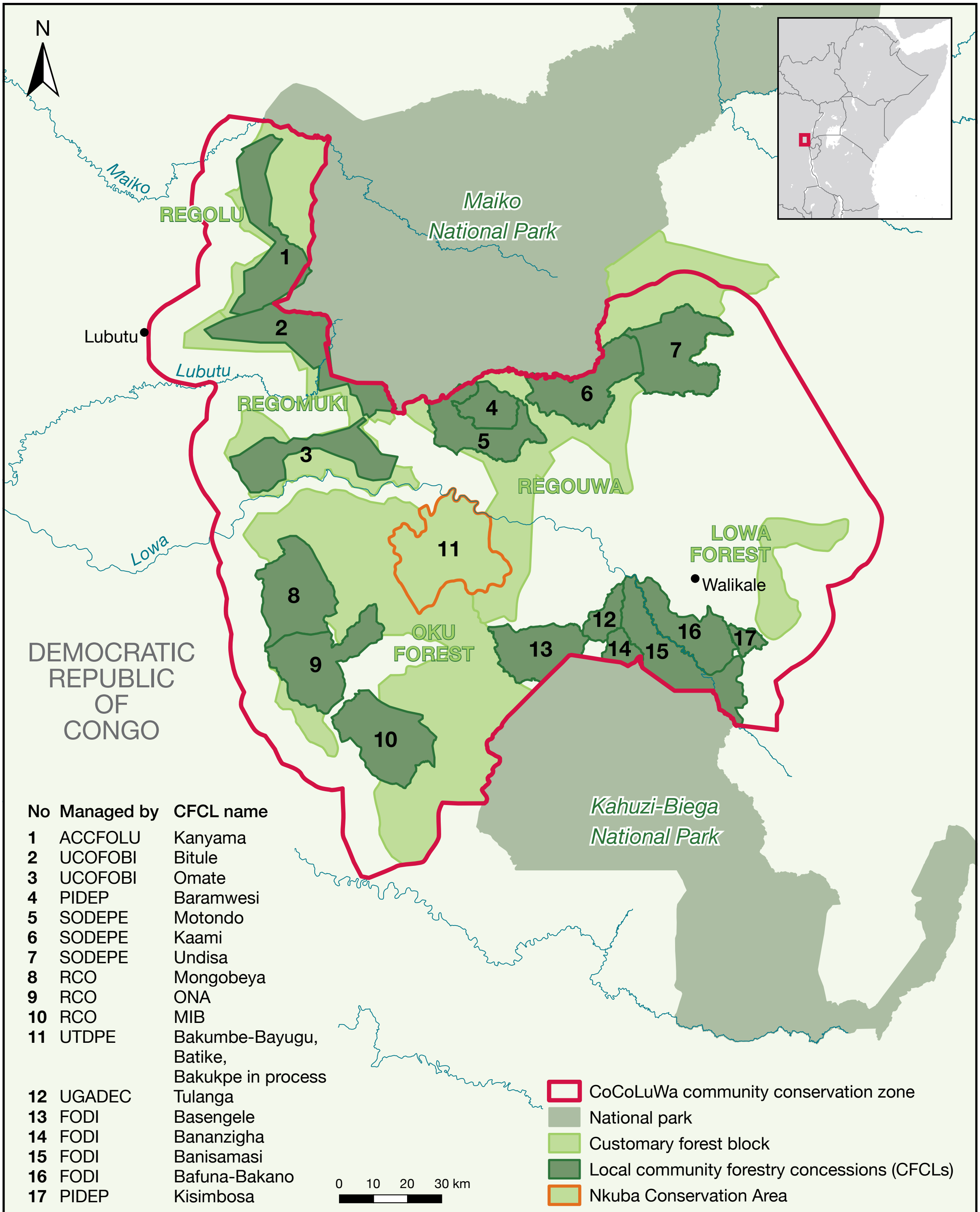


FIGURE 7.6

Notes and Sources

Notes: ACCFOLU is the Community Association for the Conservation of Forests in Lubutu; FODI is Forest for Integral Development; PIDEP is the Integrated Program for Endogenous Development of Pygmies; RCO is the Oku Community Reserve; SODEPE is Solidarity for the Development and Protection of the Environment; UCOFOBI is the Community Union for the Conservation of Forests of Bitule; UGADEC is the Union of Associations for Gorilla Conservation and Community Development in eastern DRC; and UTDPE is the Union of Landowners for the Development and Protection of the Environment.

The managing organizations of some of the community forestry concessions are supported by other members of the Ushiriki Consortium: 1: Fauna & Flora International (FFI); 2 and 3: FFI/UGADEC; 5–7: Jane Goodall Institute: 8–10: Wildlife Conservation Society; 12–15: FODI; 17: Dian Fossey Gorilla Fund International.

Sources: Developed from shapefiles supplied by JGI.

reported that agriculture was the primary livelihood activity, while 8% said it was the main income-generating activity. In addition, 22% of the residents identified hunting as a primary revenue-generating activity, and 18% named small commerce. Approximately 45% of the respondents said they consumed wild animal protein 1–3 times per week (Ellis and Nsase, 2017).

The Jane Goodall Institute conducted studies on the drivers of wild meat commerce and demand in the CoCoLuWa management unit. Results show that wild meat commerce is often a household livelihood. Women are the buyers and sellers of wild meat, often delivering supplies to hunters who may be based in artisanal mining camps in ungoverned customary forests,[7] and trekking out the products for sale in the broader region. Hunting is generally seen as family heritage and remains a male livelihood characterized by difficult work conditions. While clandestine in nature, the sale of wild meat in the CoCoLuWa management unit occurs within a traditional female space, both in the abstract and physical sense: the market. Cultural habits, price and availability affect the demand for wild meat (Muhire and Ellis, 2018, 2019). Based on this research, The Jane Goodall Institute is openly designing and testing a behavior change campaign to reduce dependence on wild meat for food security and livelihoods.

Sharing of Data and Information

In order for this model of evidence-based conservation to succeed, increased sharing of data and information is needed. To structure and archive communications, the Ushiriki Consortium uses a Slack platform that is connected to Google Drive, in which each consortium actor, strategy, committee and priority topic has a folder. Uptake of the use of these platforms is slow, however, and thus constitutes a critical challenge towards landscape-wide, evidence-based decision-making. Presentations and discussions during biannual consortium meetings tend to serve as the main opportunities for sharing knowledge and wisdom. In the future, actors may be required to demonstrate commitment to collective objectives, including activity reporting, if they wish to participate in the consortium.

Since 2015 the Ushiriki Consortium has also struggled to identify or create a database that responds to the need for analysis at scale—via great ape distribution maps, for example. Official or unofficial organizational policies often limit the sharing of raw data. Government policies also restrict sharing of data that is deemed sensitive or high-risk. In contrast, the consortium actively promotes the sharing of analyzed data, particularly as a way to address ongoing competition, conflict and disruptions in collaboration among management unit actors.

The emerging practice of evidence-based conservation in the incredibly dynamic eastern DRC is already demonstrating the value of collaborative action. Despite challenges in relation to data collection, collation and distribution, consortium actors facilitated the official designation of an additional 5,819 km^2 (581,920 ha) of customary forests in protected area buffer zones in 2018–19. These forests are designated to reconcile forest-based livelihoods with conservation of species and habitats.

Consortium actors are also helping more than 12 community associations and more than 30 communities to increase their capacity to manage customary forests. An additional 4,422 km^2 (442,185 ha) of forests are under alternative community management structures and another 3,500 km^2 (350,000 ha) of customary forests are under participatory, inclusive, community-led processes to further extend the conservation landscape. In addition, actors in the Ushiriki Consortium manage national parks, rescue and care for apes from illegal captivity; they also engage in education, awareness raising and behavior change activities with thousands of beneficiaries. Even so, the consortium will continue to focus on how best to respond to the data and information sharing and access needs.

> “Conservationists can employ systematic horizon scanning to identify nascent and future threats to ape populations, as well as conservation opportunities.”

Woodroof, 2009). The resulting expansion of the oil palm industry into orangutan habitat in Southeast Asia massively reduced available habitat and contributed to the dramatic decline in orangutan numbers, both on Sumatra and Borneo (Gaveau *et al.*, 2014; Voigt *et al.*, 2018; Wich *et al.*, 2016). Development of industrial agriculture in African great ape range countries could follow similar trajectories. Studies on spatial dynamics and potential conservation response mechanisms need to be conducted to anticipate and alleviate future threats from such development (Ancrenaz *et al.*, 2016b; Strona *et al.*, 2018; Wich *et al.*, 2014).

For horizon scanning exercises, experts from different areas compile, research, discuss, distill and communicate a prioritized list of emergent issues relating to the question at hand. In their annual, global horizon scanning exercise for environmental issues, Sutherland *et al.* (2019a) bring together a group of experts with different backgrounds and affiliations who consult literature, their networks and social media to elicit suggestions about potential topics. They collect topics, structure them thematically and then rank them based on novelty, how likely they are to occur or be implemented, and how important they would be in that case. The experts retain the topics with the highest rank and research them further to establish their relevance and produce credible evidence. Then they revisit and discuss the issues, assign final scores and draw up a shortlist, which they share with the research community, NGOs, conservation managers and politicians.

By allowing researchers and practitioners to consider both impending threats and future opportunities, regular horizon scanning can support the move beyond reactive conservation to active conservation of ape species, all of which are at an elevated risk of extinction. The integration of experts from different fields—such as politics, social sciences, psychology and economics—can also create a dialog and facilitate collaboration among stakeholders in other areas of conservation management, such as conservation planning and adaptive management, thereby further benefiting the conservation of ape species.

Conclusion

In view of recent and ongoing advances in conservation tools and methods, researchers and practitioners are increasingly well positioned to switch from a responsive to a vigilant, evidence-based approach to ape conservation. Such a shift would bolster their ability to identify and mitigate the increasing threats confronting ape populations throughout their ranges. In this context, a few practices and techniques hold particular promise.

First, conservationists can employ systematic **horizon scanning** to identify nascent and future threats to ape populations, as well as conservation opportunities. By integrating experts from a variety of disciplines and sectors, this process can also enhance collaboration among stakeholders.

Second, various **online communication options** allow for improved information sharing of up-to-date ape conservation data, findings, strategies, references and archives. Open platforms, for example, can be used to allow various stakeholders access to pertinent information; to structure communication among them; and, when uptake is widespread, to facilitate landscape-wide, evidence-based decision-making. When shared online in relevant languages, best practice guidelines for surveying and monitoring ape populations can help conservationists in many countries design appropriate research frameworks; avoid practical, analytical and data interpretation issues; assess the effectiveness of conservation interventions; report on standards of implementation; and overcome a variety of impediments.

Third, recent **developments in genetics, sensor technology and statistics** facilitate the surveying of great apes and gibbons. Among other approaches, capture–recapture methods, drones equipped with acoustic recorders and distance sampling with camera trapping can be used to survey vast areas and to generate more accurate abundance estimates. Passive acoustic monitoring with audio recording devices can also facilitate anti-poaching law enforcement.

Finally, evidence-based **conservation frameworks** can inform the design of effective context-specific strategies and assist practitioners in overcoming barriers to long-lasting species conservation. Such frameworks allow conservationists to complement their understanding of threats with a deeper awareness of the dynamics at play in local and regional socioecological systems; they also guide the process of evaluating the effectiveness of ongoing interventions, policies and strategies, as well as related obstacles, ideally through the collection of relevant information from peer-reviewed journals and gray literature, seasoned experts in the conservation field, and indigenous and other local communities. Basically, this type of framework enables scientists to build an evidence base and respond to it via adaptive management, with the aim of decreasing the rate of decline of ape populations.

Acknowledgments

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Case Study 7.1: Christina Ellis[10]

Endnotes

1 According to Ondoua Ondoua *et al.* (2017, p. viii), "The difference between hunting and poaching is the law. Poaching is the illegal killing, trapping or capture of any animal for the express purpose of either personal need or monetary gain." This chapter uses the term "poaching" to refer to the illegal killing of great apes for a number of reasons, including for wild meat; in retaliation for crop raiding or destruction; and by accident, such as through snares set for other species.

2 Note that gorilla nomenclature has changed since the 1960s. Today, the western gorilla (*Gorilla gorilla*) comprises two subspecies: the western lowland gorilla (*Gorilla g. gorilla*) and the Cross River gorilla (*Gorilla g. diehli*). In the past, the western gorilla was also referred to as "western lowland gorilla," as distinct from the eastern gorilla, today known as *Gorilla beringei* and subdivided into mountain gorilla (*Gorilla b. beringei*) and Grauer's gorilla (*Gorilla b. graueri*), a species also referred to as the eastern lowland gorilla.

3 The countries are Bangladesh, Brunei, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Thailand and Viet Nam.

4 For a comparison of methods, see Gilhooly, Rayadin and Cheyne (2015) and Höing *et al.* (2013).

5 Brockelman and Ali (1987); Brockelman and Srikosamatara (1993); Cheyne *et al.* (2016a); Gilhooly, Rayadin and Cheyne (2015); Hamard, Cheyne and Nijman (2010); Höing *et al.* (2013); Neilson, Nijman and Nekaris (2013).

6 In 1985, the Tapanuli orangutan was considered a subpopulation of the Sumatran orangutan (Wich *et al.*, 2016).

7 These are forests that are not allocated as CFCLs and do not have management plans, which would regulate the types of activities permitted in those spaces, and are required in CFCLs.

8 At the time of writing, all principal authors, unless otherwise stated, were affiliated with the Max Planck Institute for Evolutionary Anthropology (www.eva.mpg.de).

9 Borneo Nature Foundation (www.borneonaturefoundation.org).

10 The Jane Goodall Institute (www.janegoodall.org).