A photograph of a herd of elephants in a savanna setting. In the foreground, a young elephant stands facing the camera, its trunk slightly curled. It has small, white tusks. The elephant's skin is dark grey and wrinkled. In the background, several other elephants are visible, some partially obscured. The ground is dry and dusty, and the lighting suggests late afternoon or early morning, with long shadows and warm tones.

Conservation Biology in Sub-Saharan Africa

JOHN W. WILSON AND RICHARD B. PRIMACK



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The Lounsbery Foundation has generously contributed to the publication of this volume.

ISBN Paperback: 978-1-78374-750-4

ISBN Hardback: 978-1-78374-751-1

ISBN Digital (PDF): 978-1-78374-752-8

ISBN Digital ebook (epub): 978-1-78374-753-5

ISBN Digital ebook (mobi): 978-1-78374-754-2

ISBN XML: 978-1-78374-755-9

DOI: 10.11647/OBP.0177

Cover photo and design by Anna Gatti.

One of the most important international environmental treaties is the *Convention on Biological Diversity* (CBD, <https://www.cbd.int>). The CBD formulated and signed following the UN **Earth Summit** (also called Rio Summit) held in Rio de Janeiro, Brazil in 1992, has played a major role in raising awareness of the value of biodiversity to humanity. At this meeting, representatives from 178 countries formulated and eventually signed the CBD, obligating signatory countries to protect biodiversity through careful management of nature for the benefit of humans. The CBD was expanded in 2010 to also include recommendations for the protection of IUCN Red Listed species and ecosystems, as part of the **Aichi Biodiversity Targets** (Table 12.1).

Table 12.1 The UN, with governments across the world, have agreed to work on five strategic goals and 20 specific targets (collectively known as Aichi Biodiversity Targets) to halt the loss of biodiversity and protect and restore what remains.

CBD strategic goal	Aichi Target
A. Address underlying causes of biodiversity losses	1. Improve awareness of biodiversity values
	2. Integrate biodiversity values into development
	3. Eliminate perverse subsidies; incentivise sustainability
	4. Implement plans for sustainable consumption and production
B. Reduce pressures on biodiversity	5. Reduce the rate of habitat loss by at least 50%
	6. Ensure sustainable use of marine resources
	7. Ensure sustainable agriculture, aquaculture, and forestry
	8. Reduce pollution to non-detrimental levels
	9. Identify and control priority invasive species
	10. Reduce pressures on climate-sensitive ecosystems
C. Safeguard ecosystems, species, and genetic diversity	11. Increase coverage of well-managed protected areas
	12. Prevent the extinction of threatened species
	13. Prevent genetic erosion of biodiversity
D. Enable more people to enjoy the benefits of biodiversity	14. Restore and safeguard ecosystems and essential services
	15. Restore and enhance resilience of degraded ecosystems
	16. Ensure fair and equitable sharing of ecosystem services
E. Implement participatory biodiversity strategies	17. Implement participatory national biodiversity strategies
	18. Respect and conserve traditional knowledge
	19. Improve, share, and apply biodiversity knowledge
	20. Mobilise resources to address Aichi Targets

Source: <https://www.cbd.int/sp/targets>

There are also several international agreements seeking the direct protection of targeted threatened species. One of the most important treaties of this nature is CITES (*Convention on International Trade in Endangered Species of Wild Fauna and Flora*, <https://cites.org>), agreed upon in 1973 in Washington, DC. This treaty, ratified by 175 countries, establishes lists (known as Appendices) of species for which member nations agree to ban, restrict, control, and monitor international trade. Over 35,000 species of plants and animals appear on these appendices, many also listed as threatened by the IUCN. With a few exceptions, the international trade of wild-caught specimens on Appendix I is prohibited; trade in Appendix II species is strictly regulated to ensure sustainability, while trade in Appendix III species require a certification of origin. Once member countries pass local laws to comply with CITES, police, customs inspectors, wildlife officers, and governmental agents appointed for that purpose can arrest individuals possessing or trading in products from the listed species. The World Conservation Monitoring Centre (WCMC), which operates within UNEP, is tasked with managing the CITES database and monitoring whether member countries are enforcing recommendations.

The *Convention on the Conservation of Migratory Species of Wild Animals* (sometimes shortened to *Bonn Convention*, <http://www.cms.int>) is another important treaty that seeks the protection of specifically targeted species. The *Bonn Convention* came into force in 1983, and has over 120 Parties, including 37 from Sub-Saharan Africa. As with CITES, the *Bonn Convention* categorises species under Appendices. Species on Appendix I are threatened with extinction; “Range States” to Appendix I species are obliged to afford those species’ strict protections. Appendix II lists species whose populations would significantly benefit from international cooperation. Three important agreements that involve Sub-Saharan species have been concluded under the *Bonn Convention*: (1) the *African-Eurasian Waterbird Agreement* (<http://www.unep-aewa.org>), which, amongst others, things bans the use of lead shot around aquatic ecosystems; (2) the *Gorilla Agreement* (<http://www.cms.int/gorilla>), which binds Parties to protect gorillas in their habitats; and the *Agreement on the Conservation of Albatrosses and Petrels* (<https://acap.aq>), which coordinates international efforts to mitigate known threats to seabirds.

Several international agreements seek the protection of important ecosystems. Perhaps the most prominent is *Convention Concerning the Protection of the World’s Cultural and Natural Heritage* (<http://whc.unesco.org>), which protects natural (and cultural) areas of international significance. As of mid-2019, UNESCO (the organisation managing the list of **World Heritage Sites**) recognised 35 natural World Heritage Sites in Sub-Saharan Africa; this includes some of the world’s most famous conservation areas, such as Serengeti National Park in Tanzania, Bwindi Impenetrable Park in Uganda, and the Aldabra Atoll of the Seychelles. In addition, five World Heritage Sites are recognised for their natural *and* cultural significance: this includes Gabon’s Ecosystem and Relict Cultural Landscape of Lopé-Okanda, Tanzania’s Ngorongoro Conservation Area, and the Maloti-Drakensberg Park—a transboundary site composed of South Africa’s Drakensberg National Park and Lesotho’s Sehlathebe National Park (Figure 12.2).



Figure 12.2 The Maloti-Drakensberg Park World Heritage Site, on the borders of South Africa and Lesotho, protects globally significant natural and cultural heritage. Photograph by Diriye Amey, [https://commons.wikimedia.org/wiki/File:South_Africa_-_Drakensberg_\(16261357780\).jpg](https://commons.wikimedia.org/wiki/File:South_Africa_-_Drakensberg_(16261357780).jpg), CC BY 4.0.

Another important treaty that seems ecosystem protection is the *Ramsar Convention on Wetlands* (<http://www.ramsar.org>), which recognises the ecological, scientific, economic, cultural, and recreational value of freshwater, estuarine, and coastal marine ecosystems. All but three Sub-Saharan African countries have signed the *Ramsar Convention*; this binds each member country to conserve and sustainably utilise its wetlands (particularly those that support migratory waterfowl), and to officially declare at least one internationally significant wetland as protected. As of mid-2019, 252 Sub-Saharan African wetlands, covering over 1 million km², were declared internationally significant under Ramsar guidelines. South Africa and Burkina Faso have the most Ramsar Wetlands (23 and 22, respectively), while the Republic of the Congo has the largest area (138,138 km²) designated. The world's largest Ramsar wetland, the DRC's Ngiri-Tumba-Maidombe, is 65,696 km² in size (over twice the size of Lesotho!).

International treaties are particularly important to the marine environment, since about two-thirds of the world's oceans (50% of the planet) are considered international waters—that is, being outside any country's **exclusive economic zone (EEZ)**, all states have the freedom to fish, travel, do research, etc. in these areas. Three examples of international agreements protecting such marine ecosystems are (1) the 1972 *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter* (<http://www.imo.org/en/OurWork/Environment/LCLP>) which regulates pollutants into the marine environment, (2) the 1982 *Convention on the Law of the Sea* (<http://www.un.org/Depts/los>) which establishes guidelines for management of marine natural resources, and (3) the 2009 *Agreement on Port State Measures* (<http://www.fao.org/port-state-measures>) which sanctions monitoring for illegal, unreported, and unregulated fishing at shipping ports.

In addition to being party to these and other global treaties, several African countries are also members of agreements that address regional environmental concerns.

International treaties are particularly important to the marine environment, since about two-thirds of the world's oceans (50% of the planet) fall outside any country's jurisdiction.

Among the most prominent is the 2003 *Revised African Convention on the Conservation of Nature and Natural Resources* (or *Maputo Convention*). The most progressive reforms of the *Maputo Convention* include the recognition that nature is a finite resource, that the needs of future generations and traditional peoples must be considered, and that the harmful impacts of civil strife on the environment must be mitigated.

The 2016 *Paris Agreement*, which deals with greenhouse gas emission reduction and climate change mitigation, serves to illustrate the difficult political negotiations (Figure 12.3) involved in the adoption of an international treaty. Although the negative effects of climate change have been known for several decades (Section 6.1), until recently there has been a distinct lack of action to curb global greenhouse gas emissions. For example, as an early call to action on reducing greenhouse gas emissions, representatives from 154 countries signed the UN *Framework Convention on Climate Change* (UNFCCC) at the Earth Summit in May 1992. In the following years, negotiations during annual UNFCCC conferences (formally known as “Conference of the Parties”, or COPs) led in the *Kyoto Protocol*, adopted in Japan in 1997, which marked the first attempt to set legally binding emission reduction targets. Despite broad appeal among its 192 parties, the *Kyoto Protocol* faced an uphill battle from the start because the USA (the world’s biggest greenhouse gas emitter at the time) refused to ratify it, and China (which recently overtook the USA as the biggest emitter) was exempted from compliance. While this has left the *Kyoto Protocol* largely a failure, it provided important lessons that contributed to the successful passing of the *Paris Agreement* (<http://unfccc.int>), which was negotiated and adopted through consensus by 195 countries (this time including the USA and China) in December 2015. The *Paris Agreement* went into effect on 4 November 2016 after the minimum 55 countries ratified it, marking a breakthrough in the decades-long battle to curb global greenhouse gas emissions. By mid-2019, all but one country in the world (the non-signatory being the Holy See, who as UNFCCC observer nation that cannot sign but strongly support the Agreement) have signed and/or ratified the Agreement. Most relevant to African member states are the mechanisms set up to provide developing countries with large amount of aid for climate change mitigation and adaption, much of which involves ecosystem conservation (see REDD+, Sections 15.3).

While it is still too early to judge the effectiveness of the *Paris Agreement*, the 1987 *Montreal Protocol on Substances that Deplete the Ozone Layer* (<http://ozone.unep.org>) illustrates how international cooperation *can* be effective in preventing environmental disasters. In the 1970s, scientists discovered that a range of chemicals (primarily chlorofluorocarbons, or CFCs) commonly used in agriculture, energy production, and even common household items (such as refrigerators and aerosol spray canisters) were depleting the atmospheric **ozone layer**. The ozone layer is critical for human life; by cutting the amount of harmful ultraviolet radiation from the sun that reaches the Earth’s surface, protection from the ozone layer reduces skin cancer, cataracts, and crop damage. In response to this threat, the *Montreal Protocol* aimed to phase out those substances that were responsible for ozone depletion. Since then, the ozone layer has steadily recovered; current projections suggest that the ozone layer will return



Figure 12.3 A small group of COP21 delegates, led by UNFCCC Executive Secretary Christiana Figueres, negotiating the final terms of the *Paris Agreement* before its adoption on 12 December 2015. Photograph by Benjamin Géminel, <https://www.flickr.com/photos/cop21/23596677582>, CC0.

to 1980 levels in the second half of the 21st century. Towards the end of his tenure as Secretary General of the UN (1997–2006), Ghana’s Kofi Annan declared, “Perhaps the single most successful international agreement to date has been the *Montreal Protocol*”. The *Montreal Protocol*’s success is directly due to this widespread adoption and implementation.

12.2.2 National and local laws

Traditional African societies have long recognised that preserving the environment is important for human well-being. Consequently, many African cultures had mechanisms in place before the arrival of European colonists that allowed these historical societies to exploit **communal resources** on a long-term, sustainable basis. These mechanisms included mystical beliefs, local customs, and cultural taboos that ensured the protection of wildlife and land with cultural and spiritual significance. While sacred forests are prominent examples, not all sacred sites are/were forested. For example, the sandy beaches on Guinea-Bissau’s Poilão Island was also regarded as sacred by the people of the Bijagós Archipelago, ensuring the protection of one of the world’s most important green turtle (*Chelonia mydas*, EN) nesting sites (Cattray et al., 2002). These mechanisms, referred to as customary laws, also limited access to certain territories and imposed restrictions on harvesting methods, harvest times, and types of individuals that may be harvested. Strict sanctions for violations ensured that customary laws were generally followed, often through self-policing. In some ways, this traditional approach to natural resource management was not so different from certain wildlife management systems in Europe and elsewhere at the time—or even from today’s more formal law systems—which place restrictions on how we utilise nature. While some customary laws continue to regulate activities in certain regions of Africa (e.g. Walters et al., 2015), in many areas, they were lost when European authorities replaced traditional authorities during colonisation.

Today, an increasing number of international treaties and environmental organisations are achieving their conservation goals by promoting respect for and inclusion of the cultural and spiritual values that traditional peoples attach to the environment. This includes the CBD, UN, IUCN, and African Union, all promoting the integration of traditional ecological knowledge (TEK) in conservation activities and regulations (Mauro and Hardison, 2000). A growing number of national governments are also institutionalising these efforts by passing laws recognising traditional rights, providing traditional peoples with land titles, and declaring areas of spiritual and cultural significance as protected. Conservation scientists are also increasingly relying on TEK to better understand ecological networks (Sileshi et al., 2009; Gómez-Baggethun et al., 2013), to ensure sustainable utilisation of natural resources (Mbata et al., 2002; Terer et al., 2012), and to secure the continued survival of severely threatened species such as the Cross River gorilla (*Gorilla gorilla diehli*, CR), of which fewer than 300 individuals remain (Etiendem et al., 2011).

While governments are becoming increasingly respectful of customary laws and traditional lifestyles, in many areas the customs inherent to them have fallen by the wayside under increased industrialisation, urbanisation, and globalisation. An increasing number of traders of traditional products are also using more effective collection and harvesting techniques, thereby pushing many species to extinction (Section 7.2). To fill these regulatory voids and to ensure sustainable utilisation of natural resources, statutory (passed by legislatures); regulatory (passed by regulatory agencies); and case (passed by judicial bodies) laws are playing an important role in protecting Africa's natural heritage.

Laws that protect the environment (and which can be passed by local or national branches of government) can generally be divided into three categories:

- Natural resource management laws, which define the limits of fair and sustainable use of land, water, minerals, and biodiversity.
- Pollution laws, which regulate dumping of waste and other harmful substances into the environment.
- Tax incentives, which encourage environmentally responsible behaviours.

Environmental laws that address natural resource use are well known because they impact the activities of the public and some businesses. These include hunting, trapping, and fishing regulations that limit the size and number of animal and plant products that can be collected, and the equipment that can be used for harvesting. Such regulations are typically enforced through licencing requirements, harvest reporting, and law enforcement patrols. Authorities may also set up mechanisms to restrict the sale, transport, and killing of sensitive species, including restricting the sale of firearms and ammunition.

Many people have also been exposed to restrictions that control the ways in which land is used to protect biodiversity. For example, uncontrolled fires may severely

damage natural communities, so practices (such as building campfires) that contribute to accidental fires are often rigidly controlled. In some areas, vehicles and even foot traffic may be restricted to protect ecosystems and resources that are sensitive to disturbance, such as bird and turtle nesting areas on beaches, or sources of drinking water. One of the most popular methods of restricting activities in sensitive ecosystems and around sensitive resources is to pass laws that establish protected areas (Chapter 13).

Commercial operations are also subject to laws that govern natural resource use. Zoning laws, for example, prevent development of sensitive areas, such as riparian forests, beaches, wetlands, and floodplains. In areas where development is permitted, national laws typically require environmental impact assessments (EIAs, see Dana et al. 2012; Biamah et al. 2013) prior to development (Figure 12.4). Construction sites are surveyed during these assessments to ensure that damage is not done to threatened species or sensitive ecosystems. For major regional and national projects such as dams, mines, oil extraction, and highway construction, environmental impact statements must often be prepared that describe a project's potential damage, and mediatory actions taken.

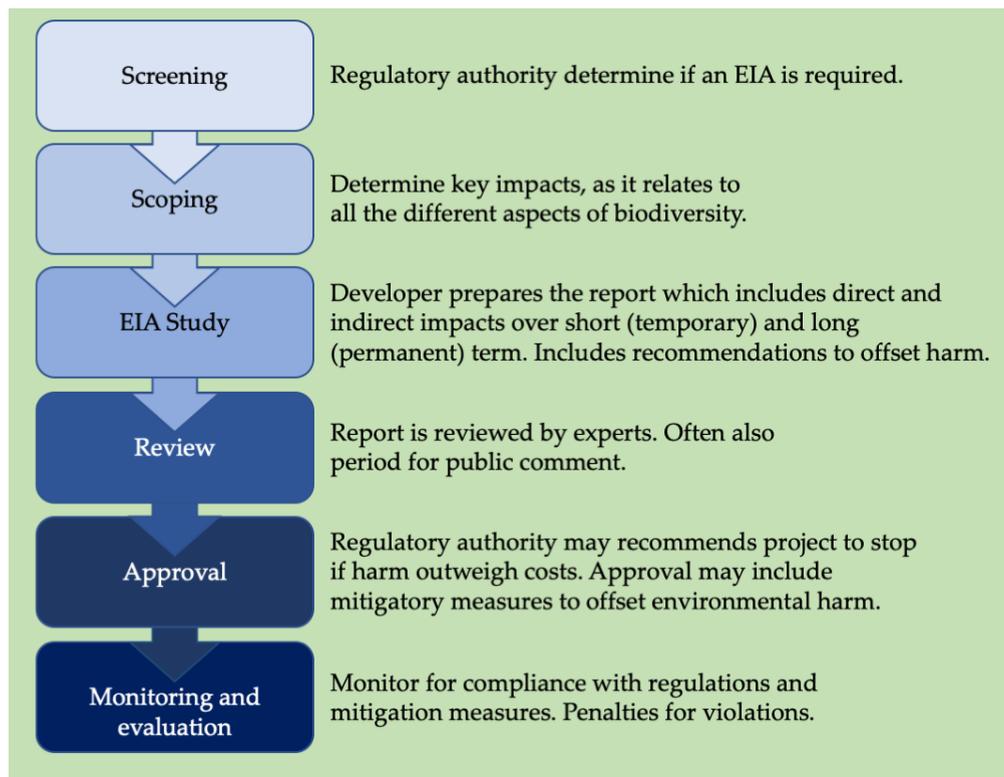


Figure 12.4 The steps required in a typical environmental impact assessment (EIA). EIAs are generally performed prior to a new development to assess potential environmental damage the development may cause, and to identify steps that can be taken to mitigate the damage. After Biamah et al., 2013, CC BY 4.0.

For industries that exploit threatened species and ecosystems, certification of a product's origin is increasingly being used as a mechanism to ensure that wild populations are not depleted by illegal collections (Poole and Shepherd, 2016). These certifications may state that environmental regulations, sustainable practices, and socially responsible methods have been followed, or that products were farmed, captive reared, or horticulturally derived rather than collected in the wild. To offset the damage caused by deforestation, various governments have recently made a concerted effort to minimise threats to their forests, including announcing timber export bans and moratoriums on commercial logging. Further afield, the USA, European Union, and Australia have also started placing bans on imported timber that was illegally harvested, some of which was sourced in Africa. Such bans are very effective in reducing the market value of unsustainably sourced products, while also increasing the market share for responsible businesses.

In recognising the immense harm invasive species inflict on the environment (Section 7.4), some countries have also enacted laws aimed at combatting invasive species. One example is South Africa, where over 500 current and potential invasive species are classified under three categories (<http://www.invasives.org.za>): Category 1 (destroy immediately, may not be owned), Category 2 (kept only with permit, no trade), and Category 3 (no trade, no breeding, but no need to remove) (Zengeya et al., 2017). Category 2 includes popular pets, such as mallards (*Anas platyrhynchos*, LC), that can hybridise with native waterfowl, as well as plants, such as gum trees (*Eucalyptus* spp.) that reduce local water availability (Section 7.4.2). Complementing this effort, the city of Cape Town's local government launched a competition (<http://www.capetowninvasives.org.za>) (with prizes) during the first half of 2017 for people who report the location for any of 28 priority invasive species.

Laws that regulate waste management and prevent pollution (Section 7.1) deal with aspects such as air emissions, sewage treatment, hazardous waste, solid waste, and wastewater dumping. In the unfortunate event that pollution ends up in the environment, such laws may also sanction contaminant clean-up. The primary aim of most pollution laws is to protect human health, property, and natural resources such as drinking water, forests, and commercial and sport fisheries. At the same time, they also protect biological communities that would otherwise be destroyed by pollution. For example, air pollution that exacerbates respiratory disease (in humans and animals) also damages commercial forests. Similarly, drinking water pollution which sickens people also kills aquatic species, such as turtles, amphibians, and fish. These examples once again show how intricately human health and economic well-being are linked to the health of the environment.

Most laws meant to protect biodiversity are restrictive in nature, but some regulations take a different tact by rewarding individuals who contribute to biodiversity conservation. Although under-utilised in Africa, perhaps the most popular regulatory reward mechanisms are subsidies and tax incentives. For example, several industrialised countries provide subsidies and tax rebates for citizens and

industries that install sustainable energy alternatives, such as solar panels, acquire greener transport options, such as hybrid and electric vehicles, and invest in **green infrastructure**, such as green roofs and permeable surfaces (Section 14.2). South Africa took its first step of this kind in 2016, when BirdLife South Africa's Fiscal Benefits Project influenced the introduction of a new tax incentive into national legislation that rewards citizens for making conservation commitments on their land (Stevens, 2017). This tax incentive allows landowners to pay reduced taxes based on the value of their land they have formally declared and manage as a protected area. (For a detailed financial analysis of a similar incentive in Canada, see Schuster et al., 2017). By financially rewarding responsible citizens, national governments can put a smile on their citizens' faces, while also saving money over the long term given that it is often cheaper to protect intact ecosystem services than restoring damaged ecosystems.

Tax incentives can encourage environmentally responsible behaviours and reward individuals who contribute to biodiversity conservation.

12.3 Environmental Law Enforcement

A single unlawful act—whether negligent or on purpose, by one single person or business—can harm countless ecosystems over a very wide geographic area. Such harm may persist for long periods of time (years, decades, and longer), and impact the lives of thousands of people. For that reason, mutual respect dictates that people and corporations alike abide by the environmental laws and regulations governing their activities. Unfortunately, while most people and businesses comply with environmental laws, it seems that there will always be those who take more than their fair share, corrupt government officials who facilitate smuggling, and greedy corporations that ignores the laws or searches for ways around them for profit. Consequently, there is a constantly need for government structures to evaluate whether environmental laws and regulations are enforced, whether violators are prosecuted, and whether amendments or new laws are needed.

Mutual respect dictates that people and corporations alike abide by the environmental laws and regulations.

Environmental laws can be enforced in several ways. In general, the system works when offences are investigated, and violators are apprehended by law enforcement officers, such as the police (Figure 12.5). Vigilant citizens can also play a role by reporting offences to authorities; financial rewards are increasingly being offered as an incentive for citizens to report environmental crimes. Some districts, environmental agencies, and protected areas may also employ dedicated environmental compliance officers, such as game rangers and anti-poaching units, to monitor human activities that may negatively impact biodiversity. Sometimes, the mere presence of environmental compliance officers is enough to deter illicit activities. With adequate enthusiasm,

training, support, and equipment, these teams can have a positive impact on an area's biodiversity and its people in a short period of time.

Figure 12.5 Rangers at Garamba National Park, DRC, found 73 kg of giant ground pangolin (*Smutsia gigantea*, VU) scales (from about 20 animals) and two elephant tusks in this handcuffed poacher's possession. Considered the world's most trafficked animals, Africa's four pangolin species (and Asia's four species) are threatened with extinction (IUCN, 2019). Photograph by Naftali Honig/African Parks, CC BY 4.0.



When caught, violators are usually punished by being charged fines and/or civil damages, and/or being sentenced to time in prison. Severe penalties can act as a strong deterrent to those who consider engaging in environmental crimes. For example, Zimbabwe recently sentenced a rhinoceros poacher to 35 years in prison (Rademeyer, 2016), Nigeria sanctioned 26 mining companies for not complying with environmental laws (NAN, 2015), and Cameroon fined two ivory traffickers US \$500,000 plus five years in prison (WWF, 2017). While such severe fines are usually reserved for major offences involving charismatic species, a South African court recently signalled that all biodiversity matters by sentencing a Spanish couple in possession of illegally collected plants to 12 years in prison, in addition to a US \$150,000 fine (Steyn, 2015). As always, it is critically important that every violator is treated equally under the law, whether the violator is the owner of a company that dumps noxious chemicals into a river, a corrupt government official who facilitates smuggling of illegal wildlife products, or an individual caught hunting illegally in a protected area.

12.3.1 New technologies in environmental law enforcement

While environmental law enforcement is the single best predictor of conservation success across Africa (Hilborn et al., 2006; Tranquilli et al., 2012), catching and

prosecuting perpetrators can be a difficult and dangerous task. Over the last few years, an increasing number of law enforcement officers have died while protecting the environment (WWF, 2016). Journalists reporting on environmental crimes are also increasingly persecuted, kidnapped, and even murdered (RSF, 2015). Well-organised environmental crime syndicates linked to drug smuggling, terrorism, and other human-rights abuses use increasingly sophisticated tools and tactics to evade detection. Moreover, armed poachers frequently outnumber law enforcement officials. Consequently, refining old and developing new strategies in environmental law enforcement are increasingly necessary.

One of the most promising developments in wildlife conservation has been the rapid development of molecular and other analytical tools and increased data processing capacity, leading to better detection, tracking, and prosecution environmental crimes. One promising development has been the increased use of genetic analysis to aid law enforcement. For example, **DNA barcoding**—a genetic analysis method that can identify the species of unknown tissue samples—helped expose illegal trade in five species of cycad (*Encephalartos* spp.), each of them threatened and listed on CITES Appendix I (Williamson et al., 2016). Elsewhere, biologists have started using stable isotope analysis—a technique that analyses an animal’s diet—to determine the origin (captive-bred or wild-caught) of parrots that are for sale (Alexander et al., 2019), and whether rare cycads were wild-collected before or after the practice was banned (Retief et al., 2014). To fully harness the power of molecular methods, wildlife agencies in South Africa and Kenya have even set up dedicated wildlife crime forensic laboratories (Wasser et al., 2007, 2015), where conservationists work closely with forensic scientists to solve wildlife crimes (Box 12.1). These initiatives have already paid off in Kenya, where molecular methods have helped increase conviction rates for environmental crimes from 43% in 2013 to over 90% in 2016 (ODPP, 2017)!

Conservationists have also become more mindful of the strategies they use to plan and conduct law enforcement monitoring. For example, park managers in Chad now use sophisticated mapping technologies to plan and monitor vulnerable wildlife as well as anti-poaching patrols (Box 12.2), while conservationists working in Cameroon are using acoustic sensors which identify times and areas of increased poaching activity (Astaras et al., 2017). Biologists in the Albertine Rift in turn use a spatial planning software package called Marxan (<http://marxan.org>)—generally used to identify the locations of new protected areas—to ensure law enforcement activities are more cost effective (Plumptre et al., 2014). To keep staff out of harm’s way and to cover more ground, environmental agencies have also started using unmanned aerial vehicles (UAVs) for law enforcement monitoring (see Box 15.1).

In Kenya, molecular methods have helped increase conviction rates for environmental crimes from 43% in 2013 to over 90% in 2016.

Conservationists are becoming more mindful of the strategies they use to plan and conduct law enforcement monitoring.

Box 12.1 Insect Biodiversity Helps Solve African Wildlife Crimes

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Poaching and pollution are crimes akin to murder and poisoning and forensic biologists have a set of vitally important tools to convict perpetrators of such crimes: insect biodiversity.

While police detectives sometimes evaluate insects found at crime scenes to help solve murders, forensic entomologists and anti-poaching investigators can use the biodiversity associated with the decomposition of carcasses to solve poaching crimes. The flies and beetles involved in decomposition are like two hands of a clock, flies ticking along in days and beetles indicating weeks.

At least 14 families of flies, including blow flies (Calliphoridae, Figure 12.A), flesh flies (Sarcophagidae), house flies (Muscidae), cheese skippers (Piophilidae), and soldier flies (Stratiomyidae), breed on carcasses in Africa (Villet, 2017), some of them arriving within an hour of the death of the animal to start the decomposition clock. They lay eggs, which hatch into larvae that eat the carcass and grow at a steady pace. The age of these larvae can be estimated by measuring their size when a carcass is found, providing a minimum time between death and discovery. The larvae eventually mature into pupae that give rise to adult flies; this process can also be calibrated to inform the timeline of evidence.

Over 90 species of beetles from at least 10 families also breed on carcasses (Villet, 2011), and can be used to cross-validate evidence from fly larvae; their longer life cycles provide a record that spans a longer period of weeks. Beetles also arrive in a sequence linked to the decomposition process. This pattern of ecological succession starts with clown beetles (Histeridae) and rove beetles (Staphylinidae) that prey on fly larvae, followed by hide beetles (Dermestidae) and carrion beetles (Silphidae) that feed on the dried tissues left by the fly larvae and, finally, by spider beetles (Anobiidae) and hair beetles (Trogidae) that eat the hair, feathers, scales, skin and cartilage left at the end of decomposition (Villet, 2011). The ecological succession clock covers a month or more, depending on the weather and the characteristics of the carcass.

Insect biodiversity can reveal other forensic details, too (Villet, 2015). For instance, insects that feed on drugged or poisoned animal tissue can bioaccumulate contaminants and provide samples for analysis even after the



Figure 12.A Adult blow flies (*Chrysomya marginalis*) emerging from a savannah elephant carcass, with barn swallows (*Hirundo rustica*, LC) feeding in the background. Photograph by Cameron Richards, CC BY 4.0.

carcass has become too decomposed to analyse directly. Insects may even indicate the presence of these contaminants through their behaviour. Animal remains that have been transported from elsewhere and dumped may harbour insects that indicate the route that was travelled. For example, poached parts of African animals bearing insects from Asia have almost certainly travelled through those areas.

The diversity of insects can also provide evidence of environmental crimes involving pollution, a field called environmental forensics. Lethal levels of pollution will change the structure of insect communities, affecting the most sensitive species first. This insight underlies the certified South African Scoring System for aquatic biomonitoring and related scoring systems developed in other African countries for rating the health of rivers based on the biodiversity of their invertebrate inhabitants (Villet, 2015). Sub-lethal levels of pollutants affect insect reproduction and development, which can be detected in impaired reproduction in adult insects and developmental anomalies in insect larvae (Villet, 2017), including increased asymmetry between the left and right sides of the body (termed *fluctuating asymmetry*) and peculiar developmental patterns. Such research is called environmental forensic entomotoxicology, and it is an exciting new field linking the study of insect biodiversity, environmental damage, and conservation biology.

Box 12.2 Protecting Elephants in a Hostile Region

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“Extinction is forever” is a phrase we hear often, but perhaps don’t consider deeply enough. The passenger pigeon (*Ectopistes migratorius*, EX) in North America is a prime example. Early naturalist accounts describe how this species were once so numerous that flocks blackened the sky, and yet it was possible to kill each one. Africa’s elephants are currently under similarly huge pressure, especially in Central and West Africa. The well documented story of the elephants of Zakouma National Park in Chad is a good example, where an estimated 4,000 elephants lost their lives between 2002 and 2010 to feed the insatiable demand for ivory (<https://www.africanparks.org/the-parks/zakouma>).

In the past, a densely-packed elephant herd was an effective defence against horsemen with spears, whose hunting method centred on isolating an individual. With armed groups coming from as far afield as Darfur, Sudan, the modus operandi of the poachers on horseback has not changed much over the past 200 years, except that the spear has been replaced with an automatic rifle. With today’s poachers shooting indiscriminately into a tightly packed herd, the result is a devastating massacre. In the past, as many as 60 elephants of all ages were killed in a single attack in Zakouma, with many dying later from festering bullet wounds and small calves ending up lost or orphaned. The trauma of such slaughter on these intelligent animals is hard to imagine and is perhaps best understood by the fact that the Zakouma herds stopped breeding for almost five years. So how does one endeavour to stop such carnage on a free-roaming population, and allow elephants to live a normal life again, especially in an open system where herds range widely?

Each area in Africa is different, and it is important to remember that what works in one area will not always work in another. To address a poaching problem, the situation must be carefully assessed, historical information evaluated, and a “feel” for the threats acquired. It is also important to remember that no anti-poaching team can function without the support staff that keeps them equipped and mobile (mechanics, buyers, bookkeepers, etc.).

Below is a list of key initiatives forming the basis of an efficient protection system for a conservation area (Figure 12.B).

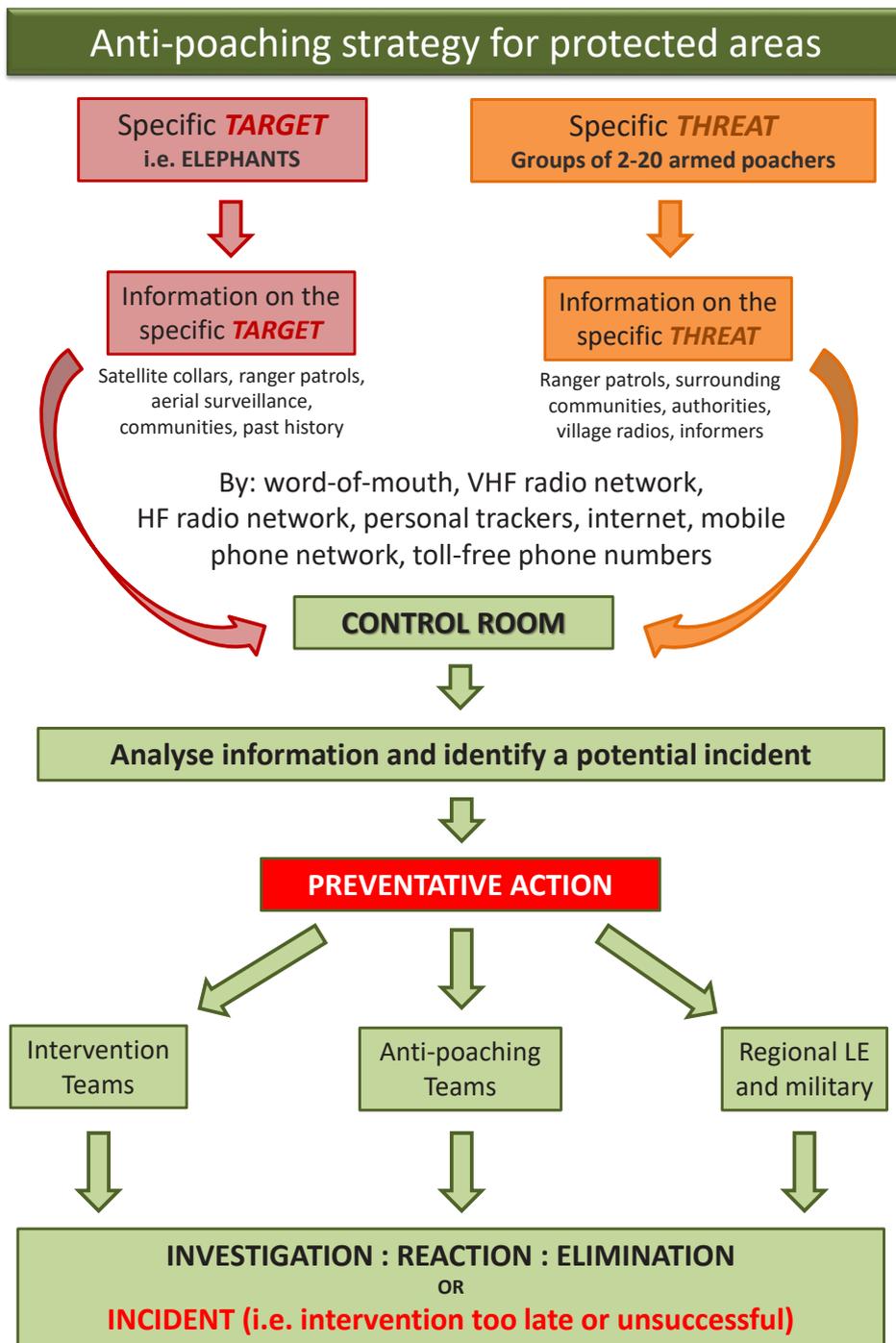


Figure 12.B (2) A flow diagram example of an efficient anti-poaching strategy for protected areas. Diagram by Parc National de Zakouma/MEP-AP, CC BY 4.0.

- *Finding and Tracking Animals*: To protect a species, a good understanding of its movements is needed. Several parks in Africa achieve this by fitting satellite GPS collars on individual elephants in different herds. Animal tracking has in the past been primarily used for research purposes, but today the data is also used to monitor elephant movements and adapt anti-poaching patrols accordingly.
- *Communication*: It is impossible to stop poaching without good communication—be it by mobile or satellite phone, a radio network, or personal trackers with a messaging function. Where the terrain allows it, a digital VHF radio network should ideally be put in place with linked relay stations and portable radios to ensure communication throughout most of the protected area.
- *Central Control Room*: A Central Control Room (CCR) (Figure 12.C) is where all anti-poaching activities are coordinated day and night. Ideally the park should work on a *predictable but unpredictable* anti-poaching system; rangers and their families know when they will be on patrol again (*predictable*), but the day-to-day deployment is *unpredictable* and coordinated by the CCR using all information available, such as real-time elephant movements, in their decision making. Where to deploy patrols should ideally be made by at least three people and the command then given to the Patrol Leaders, who are trained and equipped with GPS units. Where ranger posts or Forward Operational Bases (FOBs) are used, the unpredictable component can also include not knowing which ranger post or FOB they will be sent to, or with whom. A good rotational policy among rangers plays an important part in keeping rangers alert and motivated.
- *Anti-Poaching Monitoring Technology*: Today sophisticated mapping techniques are especially helpful for planning and reporting. Not only that, many are available at no cost on the internet. These tools allow conservation practitioners to monitor, record, and display the movements of animals, anti-poaching patrols, aircraft, and poaching incidents, and plot all of them in different layers on a map or satellite image. This is a key component to monitoring the patrol effort and coverage of an area and should be coordinated by the team in the CCR.
- *Accessibility Throughout the Year*: Although it can be difficult based on the area or budget, conservationists must be inventive in adapting to changing weather and field conditions throughout the year. Airstrips, for example, should be carefully placed to support rangers year-round; accessibility throughout the year is important for logistics but also for evacuation of ill or wounded rangers if needed.

- *Intelligence Gathering*: Not much happens in rural Africa without somebody knowing about it. The key is to get that information to your CCR. Cell phones are increasingly common, and you might also consider having a toll-free phone number. In areas without good GSM coverage, another option is to put in place a “Village Radio” system, where digital VHF radios are programmed in such a way that private calls can be made, allowing for a radio to be installed in a village and still protect the sensitive communications of a park. Having communication in key villages around a park, which speak with the CCR about any illegal activity that they have picked up in the surrounding communities, helps provide much needed security to local people and an important link with the park management.



Figure 12.C An example of a Central Control Centre, which usually operates for 24 hours every day of the year. Photograph by Vanessa Stephen/Parc National de Zakouma/MEP-AP, CC BY 4.0.

As protectors of elephants and other wildlife, park managers must assess the situation, decide what can be done in an area, and try it, but most importantly, park managers must employ an adaptive management strategy (Section 10.2.3) and *continue adapting over time to a changing situation*. Poachers change their strategies, and therefore so must park managers. Ultimately, the goal is to reduce the number of poaching incidents to allow wildlife populations to recover. This can be a daunting task with pitfalls among successes; always remember, keeping field ranger morale high is a key component to ensuring success.

In recent years, some of the world's biggest conservation organisations banded together to form the SMART (Spatial Monitoring and Reporting Tool) partnership. The main goal of the partnership is improving protected areas management, particularly environmental law enforcement, by enabling law enforcement officials and biologists to more easily collate and process information collected during monitoring and patrols. The partnership accomplishes this through the development of a freely available and fully customisable software package that includes real-time mapping, basic analysis tools, and automatic report generation abilities (Wilson et al., 2019). These features allow park managers to be more strategic in their conservation work by allowing them to better plan, evaluate, and implement their activities. SMART is rapidly becoming the standard in environmental law enforcement across the developing world, and several national governments in Africa have already adopted SMART as its environmental crime monitoring platform.

Despite this progress, older technologies are still being used very effectively in law enforcement. To name a few examples, conservationists continue to rely on tools, such as **passive integrated transponder (PIT) tags** (Gibbons and Andrews, 2004) and embedding GPS transmitters (e.g. Christy and Stirton, 2015) to identify and track stolen wildlife products such as rhinoceros horns, elephant tusks, valuable timber, and expensive ornamental plants. Lastly, environmental law enforcement officials continue to rely so heavily on well-trained domestic dogs to detect trafficked wildlife products and apprehend environmental criminals that several organisations now specialise in training dogs for conservation purposes.

12.4 The Limits of Environmental Laws and Regulations

Despite all the efforts to protect biodiversity through laws and regulations, the scale of environmental crimes continues to increase year after year. Today, the US \$91–258 billion environmental crime industry is the world's fourth largest illegal enterprise, after drug smuggling, counterfeiting, and human trafficking (Nellemann et al., 2016). Increased financial support for environmental law enforcement could certainly help: current spending to combat environmental crimes, globally estimated at US \$20–30 million a year, is a mere drop in the bucket compared to the losses incurred from these same crimes, which are 10,000 times greater (Nelleman et al., 2016).

Environmental crime is the world's fourth largest illegal enterprise, after drug smuggling, counterfeiting, and human trafficking.

There is also a need to prevent environmental crimes before they happen, given that the damages incurred cannot always be undone by punishing the offenders.

An important step towards reducing the scale of environmental crimes is to address the ineffectiveness of environmental regulations. That includes addressing the range of tactics that criminals use to facilitate non-compliance (Chapron et al., 2017), but also ensuring there are mechanisms that remove the incentives for people to

engage in environmental crimes. In the following section, we look at some of the most prominent challenges that complicate environmental law enforcement.

12.4.1 Lack of capacity

The foremost reason why environmental laws fail is that authorities often lack the capacity for effective monitoring and enforcement. Lack of capacity is a major problem in the marine fisheries industry due to the size of the oceans and the cost of patrolling them. This is particularly prominent in West Africa's oceanic waters (Figure 12.6), which experience the world's highest levels of illegal and unregulated fishing (Agnew et al., 2009; Gremillet et al., 2015). Apprehending the environmental criminals operating in these and other areas requires resources and manpower, both in short supply.



Figure 12.6 Fishermen from Tanji fishing village in The Gambia fixing their nets after a day out at sea. Intensive harvesting has reached crisis level off West Africa, where a largely unregulated fisheries industry threatens not only fish populations and the people relying on fish, but also seabirds, marine turtles, whales, and dolphins. Photograph by Jan Kruithof, <https://www.flickr.com/photos/jankruithof/30426220994>, CC BY 2.0.

Lack of capacity is exacerbated by law enforcement officers that turn a blind eye to actions they deem innocuous, or when prosecutors fail to indict criminals out of fear of reprisals. Regulatory controls may also no longer exist or be enforced in regions that experience substantial political instability, economic hardship, civil unrest, or war (Hanson et al., 2009; Beyers et al., 2011). But even in areas where regulatory controls exist, prosecution can be complex, and thus very hard, especially when the illegal activities cross international boundaries and different legal jurisdictions. Such a breakdown of legal mechanisms often leaves natural resources vulnerable to whoever can exploit them.

12.4.2 Conflicting government priorities

Clashing priorities between different government structures complicate the enforcement of environmental laws. We see this when agencies overseeing mining

activities issue inappropriate permits because of pressure for economic development, or because of corrupt agreements between businesses and government officials (Mascia and Pailler, 2011). Another example of mixed priorities occurs when a national government gives permission to extractive companies to exploit protected areas (Section 13.7.3) or communal lands without first consulting and obtaining local input and consent. Such government-sanctioned violations are generally very difficult to prosecute and require an active and caring citizenry to take their governments to task.

One of the most popular methods for citizens to make themselves heard is activist activities, such as public protests. Concerned individuals can also launch petitions on websites such as <https://www.change.org>, <http://www.greenpeace.org>, and <https://www.avaaz.org>. There is even a website for whistle-blowers (<https://wildleaks.org>) who want to report environmental crimes anonymously. Another positive development is the growing number of successful lawsuits that concerned citizens and environmental justice organisations have brought against their governments for environmental violations (e.g. CER, 2017; Yende, 2017). The Kenyan conservation organisation Wildlife Direct has taken this a step further; they are keeping citizens informed about lawsuits involving environmental crimes through a website dedicated to tracking and reporting on such cases (<https://wildlifedirect.org/legal-program-3>).

12.4.3 Informal economies, traditional activities, and the law

Law enforcement can at times be counterproductive. This is true especially in areas where the separation between informal/unreported and illegal activities is blurred. For example, traditional people who graze their livestock, collect medicinal plants, or hunt and trap animals in protected areas that were established on ancestral land seldom have criminal intent. But because formal law systems seldom account for these informal activities, those people are engaging in illegal activities. Similarly, confusing terminology may also lead to unintended conflict. For example, in some parts of Cameroon, the cultural definition of a hunter describes someone who owns a gun and makes a living from hunting animals (Hofner et al., 2018). In this context, some people consider it within the law to trap animals with snares, or even to make sporadic “hunting” trips into a protected area where hunting is forbidden, given that it is not for commercial purposes.

When dealing with vulnerable peoples whose livelihoods are threatened, an approach that involves sensitivity and compassion generally offers more effective and enduring resolutions. Many conservation initiatives have not only failed but have also created long-lasting negative attitudes by preventing traditional peoples from sustaining their livelihoods. Before implementing new regulations, governments should carefully consider if they would disrupt livelihoods. If so, it might be wise to consider if some form of sustainable utilisation isn't possible. For example, while pastoralist activities in Tanzania's

When dealing with vulnerable people, conservation initiatives must also consider impacts on livelihoods and the potential for sustainable utilisation

Ngorongoro Conservation Area may lead to wildlife declines (Boone et al., 2002, but see Ogutu et al., 2016), conservation authorities decided on a suitable compromise by allowing Maasai herders to graze their livestock in the area on the condition that they exit daily. (See also Section 13.5.2 for discussion on **zoning**.)

Despite best intentions, sustainable utilisation is not always possible, and the actions of people engaging in environmentally detrimental activities are not compatible with conservation goals. In such cases, it is important to implement controls that enable those people to transition toward sustainable activities. Failing that, conservation activities may unintentionally force the affected people to resort to illegal activities such as poaching out of desperation to obtain food and income. When banning previously-allowed activities that have become unsustainable, it helps to provide affected people with start-up resources and market access to help them comply with new restrictions while also meeting broader societal needs. For example, to fulfil income and nutritional needs when bushmeat harvesting is banned, it might be necessary to help hunters transition to farming with animals that reproduce quickly in captivity. Raising poultry can be a good alternative to bushmeat because chickens grow quickly, provide eggs, feed on insect pests, and need little land for maintenance. Farming with locally-adapted wildlife, such as large snails (e.g. Carvalho et al., 2015) and cane rats (*Thryonomys swinderianus*, LC) (e.g. van Vliet et al., 2016), has also proven to be a profitable and sustainable alternative to the bushmeat trade (for a review on wildlife farming for conservation, see Tensen, 2016). Initially, many people may resist the risks involved in leaving behind familiar activities. It is, therefore, important to explain carefully the reasoning behind those changes (e.g. “bushmeat hunting drives away tourist dollars”, Rogan et al., 2017). It may also be beneficial to enable the affected individuals to travel to areas where they can see first-hand how more sustainable activities can benefit local people.

When banning activities which have become unsustainable, it helps to provide start-up resources and market access to help affected people comply with new restrictions.

12.4.4 Trade embargoes and sanctions

The basic premise of CITES is that, so long as participating countries abide by agreed-upon regulations, trade involving species of concern will not be stopped, only monitored. However, when agreements are not met, or compliance falls short, then trade is banned in part or in whole. For example, in early 2016, following failures to comply with international trade regulations, CITES instituted blanket suspensions on trade of all CITES-regulated products against 14 African countries (CITES, 2016). Another example from 2016: after various high-profile environmental crimes that involved CITES-regulated species, the USA afforded protection to lions and elephants under their *Endangered Species Act* (<https://www.fws.gov/endangered>). Trophy hunters from the USA now face significant regulatory and logistical barriers which has all but eliminated hunting of these species for wealthy American hunters, threatening a US

\$500 million per year industry that supports over 53,000 jobs and protects over 1.4 million km² of land (SCIF, 2015). In both these examples, businesses operating within the law are unfortunately also impacted.

To avoid scenarios such as these, it is much more advantageous for pressure to mount from *within* non-complying countries and industries before outside pressure

Many formerly destructive companies are now voluntarily pursuing opportunities to prove, through special certifications, that their products are harvested responsibly and sustainably.

takes effect. To that end, many formerly destructive companies are now voluntarily pursuing opportunities to prove, through special certifications, that their products are harvested responsibly and sustainably. Four prominent certification agencies operating in Africa are the Forest Stewardship Council (FSC) which sets guidelines for the responsible management of forests, the Marine Stewardship Council (MSC) which sets standards for sustainable fisheries, the Roundtable on Sustainable Palm Oil (RSPO) which promotes sustainable production of palm oil, and the Rainforest Alliance which promotes sustainable

agriculture (For a more complete treatment of sustainability standards, see <https://www.isealalliance.org>, <https://www.evidensia.eco>, and <https://www.iisd.org/ssi>). Given that most certification schemes were established relatively recently, they are not without their flaws, but collaborations with conservation biologists (e.g. Christian et al., 2013; WWF, 2013) play a major role in ensuring continued improvements.

12.5 Conclusion

Challenging problems are often solved when a diverse group of people from different backgrounds and viewpoints come together for mutual benefit. Solving environmental crime is no different: history shows that building trust and respect for fellow human beings and future generations is more powerful than the threat of force. Effective law enforcement efforts, which require multi-level cooperation from international structures down to individual people (Box 12.3), are often characterised by partnerships between wildlife agencies and local people (Biggs et al., 2016). These partnerships may take the form of environmental educational campaigns to incentivise conservation action and sustainable resource use (Abensperg-Traun, 2009). Cooperation between different individuals at the grassroots level is another very effective means to ensure sustainable resource use. These efforts may take many forms, but they begin with individual and group decisions to prevent the destruction of habitats and species to preserve something of perceived economic, cultural, biological, scientific, or recreational value. Through collaboration and cooperation, both from the grassroots level up, and governments down, conservation biologists can achieve their goals, by ensuring free and fair treatment of all citizens regardless of their diverse and sometimes opposing viewpoints on natural resource management.

Box 12.3 Thoughts on Poaching and Illegal Wildlife Trafficking in Sub-Saharan Africa

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The two main causes of the alarmingly rapid wildlife loss in Africa today are: (1) unsustainable use of land and natural resources, mostly related to decision making that does not prioritise conservation considerations; and (2) overharvesting of wild animals and plants through poaching and illegal logging.

Poaching and illegal logging can be locally driven for subsistence use, resulting from poverty; for lack of other protein, energy, and income sources; and, at times, by the intensifying impact of armed conflict or post-conflict situations. In a country like Angola, for example, where war has significantly diminished wildlife populations, the continuous impact of intensive bushmeat poaching may well lead to the extinction of remnant core populations of species that have initially survived the armed conflict. It is severely impacting even the iconic and endemic giant black sable (*Hippotragus niger variani*, CR). Bushmeat poaching is typically unselective; it targets mainly large and medium sized mammals, but also smaller mammals, birds, reptiles and freshwater fish. Similarly, illegal logging for wood, charcoal, or slash-and-burn-based cultivation, results in rapid and irreversible biodiversity degradation and loss.

In contrast, commercial poaching is often driven by international trafficking, whether of live animals (Figure 12.D) or animal and plant products, from source countries to destination markets. Illegal traffickers are often well financed, sophisticated, and involved in other forms of serious crime, at times even in terrorism (e.g. Nellemann et al., 2014). Illegal wildlife trade is selective and forms an imminent threat to iconic species with commercial value, such as elephants, rhinoceros, big cats, great apes, pangolins, sea turtles, parrots, and rosewood, to name a few.

While the core causes, nature, and impacts of subsistence and commercial poaching are different, local community members are a centrepiece of both. Their intimate acquaintance with local wildlife and their habitats is vital; therefore, effective wildlife protection is based on their active engagement. After many generations of alienation, local community members must be included in the decision-making process for the sustainable management of natural resources. The Namibian conservancies (Section 14.3) offer a model of success in engaging communities in conservation, by protecting their rights, securing their fair benefits as the resource owners and not merely as workers, and providing them with adequate training.



Figure 12.D In 2004, Angolan authorities confiscated Massamba, an orphaned chimpanzee (*Pan troglodytes*, EN), from poachers, as part of a crackdown on the illegal wildlife trade. Photograph by Tamar Ron, CC BY 4.0.

Wildlife crime is a serious threat to biodiversity and while local influences should be recognized and addressed, these crimes should be treated as a global enforcement priority. Continuous and coordinated national efforts of all relevant sectors, and with global cooperation, are essential to success. Such efforts must include: (1) improving awareness at all levels; (2) adequate legislation and policies; (3) realistically deterring punishments and forfeiture of wildlife crime revenues; (4) strengthening enforcement and intelligence capacities in all source, destination, and transit countries; (5) addressing governance challenges; and (6) trying to eradicate the markets, or at least to reduce the demand for illicit wildlife products. The poaching drivers, international crime syndicates, and middlemen, must be targeted. Enforcement focused mostly at the poachers' level can never achieve the desired results. Often, they are no less victims than their target species. Further, if the world wants to protect iconic species, it cannot be expected that the burden of their conservation, and human-wildlife-conflict damages, should fall solely on those communities that happen to share their habitat. The global effort and substantive support required should not be viewed as a contribution, but as mutual responsibility for achieving a global goal.

Lastly, we may have to accept that total eradication of wildlife crime may not be achievable. There is no magic remedy, nor a single perpetrator. Nevertheless, integrated efforts to reduce these crimes must be strengthened at all levels. We simply cannot give up on our fellow species.

12.6 Summary

1. Environmental laws and regulations are implemented at three different levels: international treaties, national laws, and local laws. Each of these levels is intricately connected: international treaties influence—but also depend on—national laws to succeed, while national laws are guided by local needs and customary laws that have been in place for generations.
2. International treaties and conventions provide frameworks for countries to cooperate on protecting species, ecosystems, and other levels of biodiversity. International agreements are important because: (1) many species migrate and disperse across borders, (2) ecosystems do not follow administrative boundaries, (3) pollution spreads by air and water across regions and around the globe, (4) many biological products are traded internationally, and (5) some environmental problems require global cooperation and coordination.
3. National governments protect biodiversity by regulating natural resource use and preventing pollution. Subsidies and tax incentives can also be used to reward citizens and businesses that engage in environmentally-responsible behaviours.
4. There is a constant need to evaluate environmental laws and regulations to ensure that they are enforced, violators are prosecuted, and new laws and amendments are passed as and when needed. Law enforcement agencies and scientists are constantly looking for new ways to address enforcement shortcomings.
5. When banning environmentally detrimental activities that are not compatible with conservation goals, it is critical to help the affected people to transition toward sustainable activities. Failing that, conservation activities may unintentionally force those people to resort to illegal activities such as poaching out of desperation to obtain food and income.

12.7 Topics for Discussion

1. Identify two or three environmental laws regulating human activities in your country. Discuss how these national laws relate to international laws and local laws.
2. A wide range of international and national laws protect threatened species and ecosystems. Why do species and ecosystems covered by such laws not recover?
3. Trapping birds and small mammals are traditional activities for boys and young men across Africa, and traditional hunting is seen as a competitive

sport to sharpen the mind. These activities are also important to meet local income and nutritional needs. How should we deal with the hunting of threatened species outlawed by national governments, but encouraged by local traditions? Should people be allowed to hunt for bushmeat, even if it includes great apes and other rare species, to pay for necessities, such as schooling and medicine?

12.8 Suggested Readings

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13. The Importance of Protected Areas

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Sea anemones and cold-water corals are among the species that enjoy protection in the 1000 km² Table Mountain National Park Marine Protected Area (MPA), South Africa. The MPA is divided into several no-take zones which act as breeding and nursery areas for marine life, as well as zones where harvesting is allowed under certain conditions. Photograph by Andrew Beard, <https://www.flickr.com/photos/andrewbeard/13268749044>, CC BY 2.0.

With its rich biological diversity, Africa plays a critical role in global conservation efforts. Yet, many of the continent's most threatened species and ecosystems continue to face an uncertain future. In light of increasing human populations that need an increasing amount of natural resources each year, safeguarding the region's biodiversity is a major challenge. One of the best ways to meet this challenge is to designate protected areas—regions where human activities are regulated or, at times, even prohibited by law.

Biodiversity conservation is most effective when we maintain healthy, functioning, and intact ecosystems. Although it is true that many species and populations live

Protecting existing wild populations in their natural ecosystems not only protects ecological communities and interactions, but also natural processes and ecosystem services.

outside protected areas, and some wildlife populations (Craigie et al., 2010) and natural communities (Lindsey et al., 2014) are declining even when protected, well-managed protected areas continue to be the most effective method to safeguard biodiversity (Brooks et al., 2009; Ihwagi et al., 2015). Illustrating the point, a global meta-analysis, which included 952 locations across Sub-Saharan Africa, found that wildlife populations are 15% larger and species richness is 11% higher inside protected areas compared to populations directly outside (Gray et al., 2016). Differences

may be even starker at individual sites: tea fields on Tanzania's East Usambara Mountains held only 8% of the bird species present in the adjacent protected forest (Newmark, 2008), while some vultures in Eswatini now exclusively breed in protected areas (Monadjem and Garcelon, 2005). Studies from Tanzania have also shown how wildlife in protected areas are more resilient to climate change (Beale et al., 2013a), because habitat loss and fragmentation occur at four times their respective rates outside protected areas relative to inside them (see also Potapov et al., 2017). Consequently, until such a time that we can live more sustainably on unprotected lands, protected areas will remain an important cornerstone in our efforts to protect biodiversity. But how do we know what or where to protect, how much to protect, or how to effectively manage a protected area?

13.1 Establishing Protected Areas

A **protected area** is “a clearly defined geographical space (Figure 13.1), recognised, dedicated and managed through legal or other effective means to achieve the long-term conservation of nature with associated ecosystem services and cultural values” (Dudley, 2008). Given this broad definition, it comes as no surprise that governments, organisations, and local communities use a variety of mechanisms to establish protected areas. The most popular of these mechanisms are:

- Government action, which can occur at a national, regional, or local level.
- Community-based initiatives by local people and traditional groups.

- Land purchases and holdings by private individuals and organisations.
- Protected areas established through co-management agreements.
- Development of biological field stations or marine laboratories.



Figure 13.1 Land clearing and agricultural development pushes right up to the eastern edge of Bwindi Impenetrable National Park, Uganda. It is important for protected areas—and zones within those areas—to have clearly defined boundaries to avoid confusion on where and how human activities are regulated. Photograph by Jason Houston/USAID, <https://www.flickr.com/photos/usaid-biodiversity-for-estry/38484053220>, CC0.

13.1.1 Government protected areas

Government actions are generally considered the most secure form of protection because they involve passage of laws and buy-in from multiple levels of society. Of course, legislation establishing a protected area does not guarantee that the species and ecosystems therein are adequately preserved. Small populations, especially those living in small protected areas, often require active management (Section 8.7.5) to ensure their continued survival. Another concern is that laws protecting national parks and other wildlife sanctuaries are not strictly enforced, leading to so-called paper parks—parks that appear on official government lists, but with wildlife monitoring, law enforcement, and ecosystem management lacking on the ground (Laurance et al., 2012). However, government-sanctioned protected areas do lay a solid foundation for partnerships among governments, international conservation organisations, multinational banks, research institutes, and educational organisations. Such partnerships can bring together funding, training, and scientific and management expertise to maximise the potential value of those protected areas.

13.1.2 Community conserved areas

In many areas, local people already protect biological communities, forests, wildlife, rivers, and coastal waters in the vicinity of their homes. Protection on these **community**

Traditional communities may link cultural advocacy to conservation by establishing protected areas as a safeguard against developments that would compromise their way of living.

conserved areas is enforced by village elders and councils to ensure the sustainable use of natural resources such as food supplies and drinking water. Natural areas have also been set aside by royal families and churches to provide a space for spiritual activities (see Box 2.1) and sustainable harvesting of medicinal plants (see Box 5.2). Because human activities are highly restricted in these sacred spaces, they provide an important refuge for biodiversity. Today, an increasing number of traditional communities link cultural advocacy directly to conservation through the establishment of protected areas on their lands as a

safeguard against developments that would compromise their way of living. Other communities establish protected areas to attract tourists and ensure the protection of special wildlife. One such example is the Iyondji Bonobo Community Reserve in the DRC, which protects bonobos (*Pan paniscus*, EN), forest elephants (*Loxodonta cyclotis*), as well as one of the world's most enigmatic birds, the Congo peafowl (*Afropavo congensis*, VU) (Dupain et al., 2013).

13.1.3 Privately protected areas

Over the last few decades, many African countries have adopted a more Western form of land tenure under private ownership. Wealthy individuals or groups of people

Because the ecotourism potential of private protected areas depends on how they are managed, landowners prioritize maintaining and even increasing wildlife populations on their land.

have taken advantage of this opportunity by acquiring large tracts of land for ecotourism purposes (de Vos et al., 2019). Because the ecotourism potential of these privately protected areas depends on how well the property is managed (Clements et al., 2016), private landowners often invest considerable effort to maintain and even increase wildlife populations on their land. Privately protected areas have unique advantages over government-protected areas. For example, they have local buy-in from landowners and their employees by design; this is often a significant

stumbling block for government-protected areas. Private sites could also employ innovative funding mechanisms that allow them to fast-track land acquisition, perhaps in response to threats such as development. In some areas, privately protected areas may even employ more people, pay better wages, and contribute more to local economies than government protected areas (Sims-Castley et al., 2005). Privately protected areas can, therefore, play a significant role in overall conservation efforts (see Box 2.3), particularly in areas where threatened species (Cousins et al., 2010) and ecosystems (Gallo et al., 2009) are underrepresented in government-protected areas.