Chapter 2
Animal Conservation in the Twenty-First Century

Hugh A. H. Jansman

Abstract Biodiversity on Earth is rapidly decreasing and the situation in the Netherlands is in that perspective a textbook example. The main causes for species extinction are habitat loss, landscape degradation and overuse. Conservation efforts should focus more on the level of viable ecosystems. A strategic plan to do so is called Cores, Corridors and Carnivores (rewilding's three C's). This requires strong Cores of nature, mutually connected via robust Corridors. Based on island biogeography theory it can be calculated that if we want to conserve roughly 85% of the current biodiversity, 50% of the Earth's surface needs to be protected, 'Nature needs half'. For healthy ecosystems we need to get top-down forcing by apex consumers back in ecosystems. These apex consumers are mainly large Carnivores, and bringing them back asks for coexistence. If we want to keep our living conditions on planet Earth healthy we have to change our unsustainable way of living and change our way of thinking with respect to nature, natural processes and our relation with other species. The loss of biodiversity can only be halted or reversed if we save more space for nature and natural processes including top-down forcing and last but not least, find a way of coexistence with our fellow creatures.

2.1 Introduction

Conditions for life as we know it are exceptionally favourable on Earth compared to other known planets in the universe. In billions of years, evolution has created a very rich biodiversity. Biodiversity includes biological variation, whether it is at a genetic, species, population or community level, or even at their ecosystem-level interactions (Wilson 1992). Yet, the biodiversity that happens to coexist with us humans being, the dominant life form in the so-called Anthropocene, faces the 6th mass extinction (see Bovenkerk and Keulartz in this Volume). World Wildlife Fund (WWF) reported

H. A. H. Jansman (✉)
Wageningen Environmental Research, Wageningen, The Netherlands
e-mail: Hugh.jansman@wur.nl

© The Author(s) 2021

B. Bovenkerk and J. Keulartz (eds.), *Animals in Our Midst: The Challenges of Co-existing with Animals in the Anthropocene*, The International Library of Environmental, Agricultural and Food Ethics 33,
https://doi.org/10.1007/978-3-030-63523-7_2

that population sizes of wild animals on average have been reduced with 60% since 1970 (WWF living planet report 2018). Main cause is the rapid growth of the human population in the last centuries, in combination with an unsustainable way of living by humans, especially in 'Western' societies. Since human population growth is still continuing and developing countries rapidly adopt Western consumption patterns, the living conditions for many species on planet Earth are gradually decreasing (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; IPBES report 2019). Humans dominate the global ecosystem in three ways: by land use, the nitrogen cycle and the atmospheric carbon cycle (Primack and Sher 2016). Firstly, human land use, mainly for agriculture, and our need for resources, especially forest products, have transformed as much as half of the Earth's ice-free land surface from natural to cultural lands. Regionally this can be more than 90%. Secondly, each year human activities release more nitrogen into terrestrial systems than natural biological and physical processes, for instance by cultivating nitrogen-fixing crops, using nitrogen fertilizers and burning fossil fuels. And thirdly, human use of fossil fuels and the unsustainable cutting down of forests will result in a significant increase of the concentration of carbon dioxide in the Earth's atmosphere. Scientists have determined ten planetary boundaries that should not to be exceeded if we want to keep the living conditions on earth favourable for us and many other species. Three of those boundaries are already exceeded: biodiversity loss, climate change and the nitrogen cycle (Fig. 2.1). It is no surprise that within ecosystems those boundaries are all

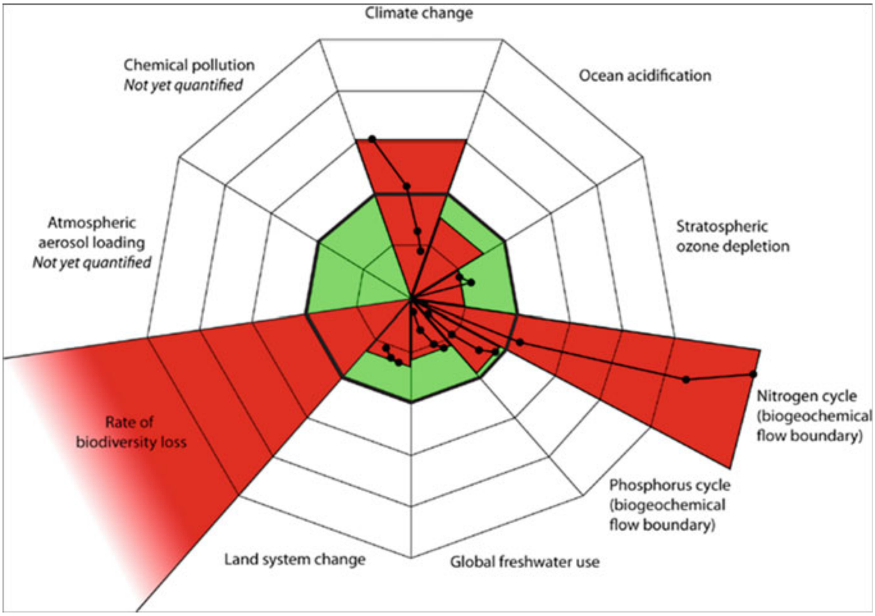

Fig. 2.1 Estimate of quantitative evolution of control variables for seven planetary boundaries from pre-industrial levels to the present (from Rockström et al. 2009)

interconnected. They are different faces of the same central challenge: the increasingly dangerous impact of our choices on the health of our natural environment.

2.2 Viable Populations

The main causes for species extinction are habitat loss (destruction), habitat degradation (e.g. by pollution, fragmentation or invasive species) and overuse (unsustainable hunting, fishing, logging etc.). Due to the destruction of large parts of their habitat, many populations of wildlife have decreased in size. Besides the demographic risk of being more prone to extinction by occasional drops in numbers due to dramatic events (e.g. disease or wildfire), such small populations will also gradually loose genetic variation. Reduced mating choice, and therefore a higher risk of inbreeding, will further reduce diversity and potentially result in reduced viability and/or reproductive capacity (i.e. inbreeding depression). Furthermore, the loss of genetic variation limits a population's adaptability to change, while gradually moving along with changing climate zones is for many species impossible due to barriers in the landscape. Not to mention that climate change is currently going much faster than the speed in which most species can change their distribution area. Finally, barriers for dispersal between fragmented habitat patches also limit the natural restoration of local diversity by (re)immigration (Frankham et al. 2010).

At the end of the 1970s, the rapid increase of species extinctions gave rise to a new field of science: conservation biology. This young discipline deals with the management of nature and of earth's biodiversity with the aim of protecting species, their habitats and ecosystems, from excessive rates of extinction and the erosion of biotic interactions. It is an interdisciplinary research area drawing not only on natural but on social sciences as well, and also on the practice of natural resource management.

Conservation biologists conduct monitoring programmes to evaluate the status of populations and ecosystems. They label species that have significantly been reduced in number and/or distribution area as threatened. Depending on specific criteria, these species are listed on a conservation priority list, the Red List. This list of threatened species was established by the International Union for Conservation of Nature (IUCN 1964) and has evolved to become the world's most comprehensive information source on the global conservation status of species. What followed were international agreements for biodiversity conservation, such as the Convention on International Trade in Endangered Species (CITES 1973), the Bern Convention (1982), and the Convention on Biological Diversity (Earth summit; Rio de Janeiro, 1992).

These agreements strive to protect the most endangered species. The populations of endangered species are frequently divided in small subpopulations due to habitat fragmentation. As a result conservation is in most cases focussed on important subpopulations and not the whole population. If conservation of a threatened species is intensified, a four step approach of restoration is launched in an attempt to get a red listed species viable again. Step 1 is to secure the area in which a threatened (sub)population is living; its distribution area. Step 2 is to find out which specific factors are negatively influencing the population, and mitigate them. Step 3 is to enlarge the current distribution area with additional suitable habitat for the species. Step 4 is the connection of the isolated subpopulation with a corridor to another subpopulation, allowing for natural dispersal and gene flow. To some extend this 4-step approach is adopted in (inter)national nature policies. Europe's Natura 2000 directive, as implemented in its member states, focuses on the protection of remaining habitat and strives to reconnect them via e.g. fauna passages and corridors.

2.3 Sufficiently Large Numbers and the Amount of Area They Require

One of the biggest questions in conservation biology is which qualities populations must have in order to be able to survive in the long term. How many individuals are needed for a population to reduce the risk of extinction to a bare minimum? And furthermore, what size of habitat is required to sustain such a population?

The term *Minimum Viable Population* Size (MVP) was first introduced by Shaffer (1987) and defined by him as "the smallest isolated population having a 99% chance of surviving for 1000 years despite the foreseeable effects of demographic, environmental, and genetic stochasticity, and natural catastrophes". Variation in the size of a population depends on those factors. They all may have a temporary or permanent negative impact on the population size. Chance events play a strong role here (Shaffer 1987). A natural catastrophe may lead to abnormally high mortality rates, climate conditions may fluctuate and genetic variation may be lost as a result of chance effects in the presence of particular gene variants (genetic drift; Nei 2005). In addition, negative demographic, environmental and genetic influences may produce a synergistic effect which in extreme cases may result in ever increasing contraction: the extinction spiral (Blomqvist et al. 2010). A viable population must therefore be sufficiently large to avoid finding itself in such a spiral as a result of chance events. Unsustainable use, invasive species, pollution or bad luck are otherwise easy executioners.

Ideally, genetic-, demographic- and environmental factors will be taken into account in an estimate of the MVP, through what is known as a *Population Viability Analysis* (PVA). As part of the analysis, the likelihood of a population becoming extinct within a certain number of years is calculated on the basis of context-specific assumptions, like the mating system of the species, sex-ratio in the local population and population dynamics. Since a greater number of potential risks are taken into consideration, MVP estimates based all factors usually result in higher numbers than estimates based on genetic risks alone (Ottburg and van Swaay 2014). Traill et al. (2007) compared as many published MVP estimates as possible from the previous 30 years, based both on PVA analyses and on population-genetic models, and found major differences between species and also between populations of the same species. They therefore concluded that context is of overriding importance in practice. Nevertheless they provided average values for each species group. For mammals the safe threshold for a minimum population size was set at ~2.900 individuals; for birds, reptiles and amphibians, and fish the threshold was set at respectively ~3.300, ~4.000 and ~500.000 individuals. With the estimated safe threshold of ~2.900 individuals of a mammal species one can imagine that huge areas are needed to provide sufficient habitat for these species.

Animals need sufficient food and shelter in their habitat, so densities of species depend on the quality of an area. Habitat with poor soil conditions, harsh climate conditions and little cover carry lower densities of species then rich habitats. The threshold numbers mentioned above are relatively easily met for small rodents that need small areas, but for populations of for example deer there are not many areas in Europe large enough to sustain such a large population, not to mention viable populations of carnivores like bears and wolves. This explains why so many species have difficulty surviving, specifically the ones requiring large areas.

So what is the relation between the size of a nature reserve and biodiversity? MacArthur and Wilson (1967) studied the distribution of biodiversity on islands. What they found is that the larger an island, the richer the biodiversity. They developed a formula for the species-area relationship, the so-called island biogeography model. It predicts that islands of 10, 100, 1000 and 10,000 km^2 in size would have 2, 3, 6, and 10 species respectively. Each tenfold increase of the size of an area increases the number of species by a factor of approximately 2. But the opposite is true as well. Reduce the area of an ecosystem to one tenth and you lose roughly half of your biodiversity. Since humans transformed huge areas in a way that ecosystems are highly degraded and fragmented, one can speak of islands of nature in a sea of human dominated landscapes. Therefore the island biogeography model can to a large extent be applied to nature areas on the mainland. However, the extent to which the suboptimal landscape surrounding a patch of key habitat is in fact still used by a species is not always exactly known, and may be underestimated.

What is also important is the level of population fragmentation. If the distribution area of a population is fragmented, we talk about multiple subpopulations. A subpopulation can be isolated, meaning there is no dispersal to surrounding subpopulations, or it can be connected via corridors allowing for exchange of individuals. This exchange is important for survival since it counters stochastic effects in subpopulations and prevents genetic degradation. A cluster of subpopulations with mutual exchange we call a 'metapopulation'. It is clear that many of today's fragmented nature conservation areas provide inadequate resources for self-sustaining populations of thousands of individuals. The solution lies in preventing or ending isolation: creating corridors between nature areas. The above mentioned definitions of MVP's are all based on a self-sustaining, isolated population (Shaffer 1987; Franklin 1980). However, when several populations are combined to form a larger population or metapopulation in which regular dispersal takes place, the variation lost in a subpopulation may be restored by immigration from another subpopulation (Frankham et al. 2010). A criterion of one migrant per generation is often applied to avert the negative consequences of inbreeding and genetic drift (Mills and Allendorf 1996). In short, where there is a regional metapopulation and each subpopulation receives a migrant which contributes to reproduction at least once a generation, the aforementioned genetic guidelines for an MVP will apply to that regional metapopulation as a whole (Mergeay 2012).

The way we manage wildlife can have its effect on the viability of a population and the integrity of a species as well. For instance management of ungulates is mostly done by a random cull of a large proportion of the population each year. In the Netherlands roughly 50% of the red deer and 75% of the wild boar population is randomly shot each year in order to reduce the conflict with human interests like traffic mortality and crop damage (Faunabeheereenheid Gelderland 2019). We can only guess at the consequences of reducing such large numbers for population structure, vitality, genetic variability, adaptation and behaviour. In those heavily managed populations almost all females participate in reproduction. Whereas in an unmanaged population, only the best animals reproduce due to mutual competition for resources. The mechanism of evolution is based on the principle that within a population, individuals have different characteristics. Some of those characteristics are inheritable and some of those characteristics might result in better survival and/or reproductivity. This results in selection and adaptation, survival of the fittest. Recently this process was illustrated in a wild red deer population on the isle of Rhum, Scotland. In this wild population the average parturition date has advanced by nearly 2 weeks in 4 decades in a response to climate change (Bonnet et al. 2019). Is this driving force of life still possible in populations that are predominantly managed by us?

And what about management of populations by ‘removing’ the individuals that cause trouble? For instance, a bear that learns to associate humans with food might start to eat from trash cans, or feral horses that are being fed by tourist might become pushy. These individuals are often removed from the area, because they showcase behaviour that is unwanted by the public or managers. By doing so we probably select for characteristics that we humans prefer, resulting in a kind of taming or domestication of wild species and therefore interfere with the process of natural selection (Donaldson and Kymlicka 2016).

In my opinion this is where we stand: scientists have a fairly accurate estimation of how many individuals a viable populations should contain and we can estimate how large suitable areas should be to hold those populations. But for more and more species that is hard to achieve, if human demands for land and resources are not reduced. This results not only in dwindling species, but in an increase of conflict potential between nature and humans, since we penetrate more and more into the last remaining nature areas (see the chapters of Drenthen and Tokarski in this Volume).

2.4 Challenges

The focus of conservation is relatively more on individual threatened species rather than on healthy ecosystems, partially due to international agreements. Measures taken for one species can be detrimental for another. As a result species conservation becomes kind of similar to gardening. Per nature reserve we pick a few target species to conserve or, in fact, manage. While even if those target species are carefully selected to represent key functions or habitat needs, this undervalues a system's complexity. Some species, like ungulates and so called pest animals, are managed by culling in order to control their numbers and therefore avoid conflicts with human interests. Disease transmission, naturally occurring in wildlife and potentially spilling over to humans and our livestock (specifically zoonoses like Covid-19) is a topic that gets more and more attention. These management decisions are predominately taken from the perspective of human interest and less so in the interest of nature.

Altogether, while awareness of the need for biodiversity conservation is on the rise, realizing it in practice is very difficult (IPBES 2019), even more so since the pressure of humans and human activities on planet Earth is still increasing. There seems to be a constant and growing conflict between humans and wildlife combined with less than optimal species conservation since the needs of viable biodiversity are not met. As a result extinctions are ongoing. A similar example are efforts to mitigate climate change: while this is a topic that most people are nowadays well aware of, the political and societal will to take preventive measures is meeting resistance, as such measures may directly impact our current life style.

2.5 Trophic Downgrading: "When the Cat Is Away, the Mice Will Play"

Up to now I've mainly discussed the conservation of species. But more and more scientists are becoming aware how important interactions are between organisms in an ecosystem. Erosion of ecosystems rapidly continues to this date, especially due to nature policy often ignoring the fact that ecosystems consist of complex interactions between species. When a species becomes extinct a much more insidious kind of extinction occurs as well: the extinction of ecological interactions (Estes et al. 2011). If the link between all species in the system is weakened, or even gone if species became extinct, resilience of the entire system is affected. This might for instance lead to an overabundance of deer if predators like wolves are absent, or exotic species easily becoming invasive in eroded ecosystems. On a broader scale the reduction in megafauna on earth has severely constrained the flow of nutrients across continents and between the oceans, freshwaters and land (Jepson and Blythe 2020)

Estes et al. (2011) states that one of humankind's most pervasive influences on nature is probably the eradication of species at the top of the food chain. These so-called apex consumers were ubiquitous across the globe for millions of years. Apex consumers are mainly large carnivores, but can be megaherbivores as well, like elephants and rhinos whose adults are largely immune to predation. Recently scientists have become aware how extensive the cascading effects of their disappearance are in marine, terrestrial and freshwater ecosystems worldwide. Miller et al. (2001) explain the importance of large carnivores for healthy ecosystems. The absence of top-down forcing in ecosystems by apex consumers is called trophic downgrading. Ecosystems may be shaped by apex consumers, their impacts spreading downwards through the food webs (Estes et al. 2011; Keulartz 2018). An example is the influence of apex consumers like wolves in supressing herbivory. Regarding biodiversity Estes et al. (2011) mention the fact that most protected nature areas don't function as intended due to the absence of large apex consumers. This may result in species from lower trophic levels spinning out of control, although our current understanding is too limited to predict such effects in detail. As a result, our society may be confronted with ecological surprises, such as pandemics, population collapses of valued species, population eruption of species we dislike, shifts in ecosystem state and loss of ecosystem services. According to Estes et al. (2011) top-down forcing must be included in conceptual overviews if there is to be any real hope of understanding and managing the workings of nature.

2.6 Conservation in Twenty-First Century: 'Cores, Corridors and Carnivores' Meets 'Nature Needs Half'

If we want to conserve our biodiversity we should focus on robust and complete ecosystems, including the presence of large apex consumers. We should change the conservation focus from mainly species oriented management to self-supporting sustainable ecosystems. A strategic plan to do so is called Cores, Corridors and Carnivores (rewilding's three C's; Soulé and Noss 1998). For sustainable conservation, ecosystems require large units of nature (Cores), mutually well connected (Corridors) and the presence of Carnivores for their top-down forcing as apex consumer. For the Netherlands a similar concept was already invented as the three E's of nature development: Ecological core areas, Ecological corridors, and Ecological networks (Baerselman and Vera 1989). For many nature reserves this means that their size should increase, robust corridors should be created allowing for sufficient dispersal potential and gene flow, and apex consumers are returned. This approach is named restoration ecology or rewilding, which overlap. Restoration ecology is the practise of restoring the species, landscapes and ecosystems that occupied a site at some point in the past, but were damaged or destroyed. It normally follows the four step approach mentioned earlier, but frequently with the addition of reintroducing original species as well (www.ser.org). Rewilding, or trophic rewilding, aims at maintaining or even increasing biodiversity through the restoration of ecological and evolutionary processes using extant keystone species or ecological replacements of extinct keystone species that drive these processes (Svenning 2016; Keulartz 2018). Whereas restoration has typically focused on the recovery of plant communities, rewilding often involves animals, particularly large carnivores and large herbivores. Whereas restoration aims to return an ecosystem back to some historical condition, rewilding is forward-looking rather than backward-looking: it examines the past not so much to recreate it, but to learn from the past how to activate and maintain the natural processes that are crucial for biodiversity conservation (Keulartz 2018; Jepson and Blythe 2020). Restoration ecology and rewilding both use reintroductions in their conservation approach (Box 2.1).

Box 2.1 Examples of Reintroductions

(1) *Reinforcements*, involving the release of an organism into an existing population of conspecifics to enhance population viability.
(2) *Reintroductions*, where the intent is to re-establish a population in an area after local extinction, or, more from the rewilding perspective, has the intent to restore ecological and evolutionary processes.
(3) *Assisted colonization*, the intentional movement of an organism outside its indigenous range to avoid extinction of populations due to current or future threats.
(4) *Inter situ*-conservation, the so called One Plan approach which was launched in 2012 by the IUCN. This approach stimulates the interactive exchange of animals between in situ populations (in nature) and ex situ populations (in captivity) to increase the viability of the species.
(5) *Ecological replacement*, (more from the rewilding perspective) the release of an appropriate substitute species to re-establish an ecological function lost through extinction. Examples are back breeding, taxon substitution and de-extinction, all subject to scientific controversy.

It is clear that the realisation of sustainable ecosystems requires huge areas. Co-inventor of the island biogeography model (before mentioned) and one of the founding fathers of nature conservation E.O. Wilson started the half-earth project. His goal: “With science at its core and our transcendent moral obligation to the rest of life at its heart, the Half-Earth Project is working to conserve half the land and sea to safeguard the bulk of biodiversity, including ourselves” (www.half-earthproject.org). According to Wilson (2016) and based on IUCN data, there are now roughly 160.000 nature reserves on land and 65.000 in sea areas, covering 15% of the continents and 2.8% of the oceans. The island biogeography model is still relevant since more and more nature reserves now function as islands due to isolation. Wilson states that a 90% reduction of the size of nature areas is currently the case in many locations all over the world. This size reduction results in only 50% of the current existing species being able to maintain viable in the long term, a reduction of biodiversity in time with another 50% on top of what’s already lost. The opposite can be done as well. Wilson calculated that in order to conserve roughly 85% of the current biodiversity, 50% of the earth surface needs to be protected: therefore the program’s name: ‘nature needs half’. So the aim is to reserve roughly 50% of the earth’s surface for nature in order to prevent further loss of biodiversity and sustainable living conditions for biodiversity and us humans as well. The focus is on biodiversity hotspots around the equator, but all ecosystems should be conserved. According to these figures, nature reserves on earth have to be enlarged with roughly 35% and in seas with 47.2%.

2.7 Viable Ecosystems with Red Deer and Wolf in the Netherlands

The Netherlands is a relative small country with a high human density and an even higher livestock density. It is considered to be the second largest exporting country in the world regarding agricultural products (see Bovenkerk and Keulartz in this Volume). As a consequence there are many environmental problems like nitrogen deposition and pesticides. Still there is wildlife left in the Netherlands, although management is quite intensive and many populations suffer from habitat destruction, fragmentation and high traffic mortality. I will discuss two species in detail, red deer (*Cervus elaphus*) and wolf (*Canis lupus*), as examples of what a future desirable arrangement of the Netherlands would have to look like to hold viable populations of wildlife with self-serving ecosystems including top-down forcing by large ungulates (megafauna) and carnivores, and less conflict potential with human interests.

2.7.1 Current Population of Red Deer in the Netherlands

There are two Dutch nature reserves where large populations of red deer are allowed; the Veluwe (circa 1000 km^2; of which 912 km^2 is a Natura 2000-area) and the Oostvaardersplassen (a Natura 2000-area of circa 56 km^2, of which 20 km^2 is used by herbivores for grazing); see Fig. 2.2. Both areas are more or less fenced in, so they are closed populations.

The Veluwe is a relatively poor soil forest-heather ecosystem. Although it appears from a birds perspective to be one large area, it is fragmented due to many fences. Ecoducts have been built to allow dispersal and to stimulate the mixing of the subpopulations of red deer. However, genetic research shows that these ecoducts do not function fully yet. Genetic research shows that the populations do not mix optimally, probably as a result of these (partial) migration barriers (De Groot et al. 2016). The population of red deer is about 2500 individuals (Groot Bruinderink 2016). Management cull is about 50% of the annual population size in order to prevent crop damage and traffic collisions which leads to conflict with human interest. Forestry and forest rejuvenation is another reason to keep the herbivore density low (Den Ouden et al. 2020). Therefore the population density is much lower than the carrying capacity of the area and as a result mutual competition amongst the deer is low, resulting in all hinds having a calf each year.

The Oostvaardersplassen is very rich in minerals with abundant growth of vegetation. The population of red deer was not managed since there was no conflict with

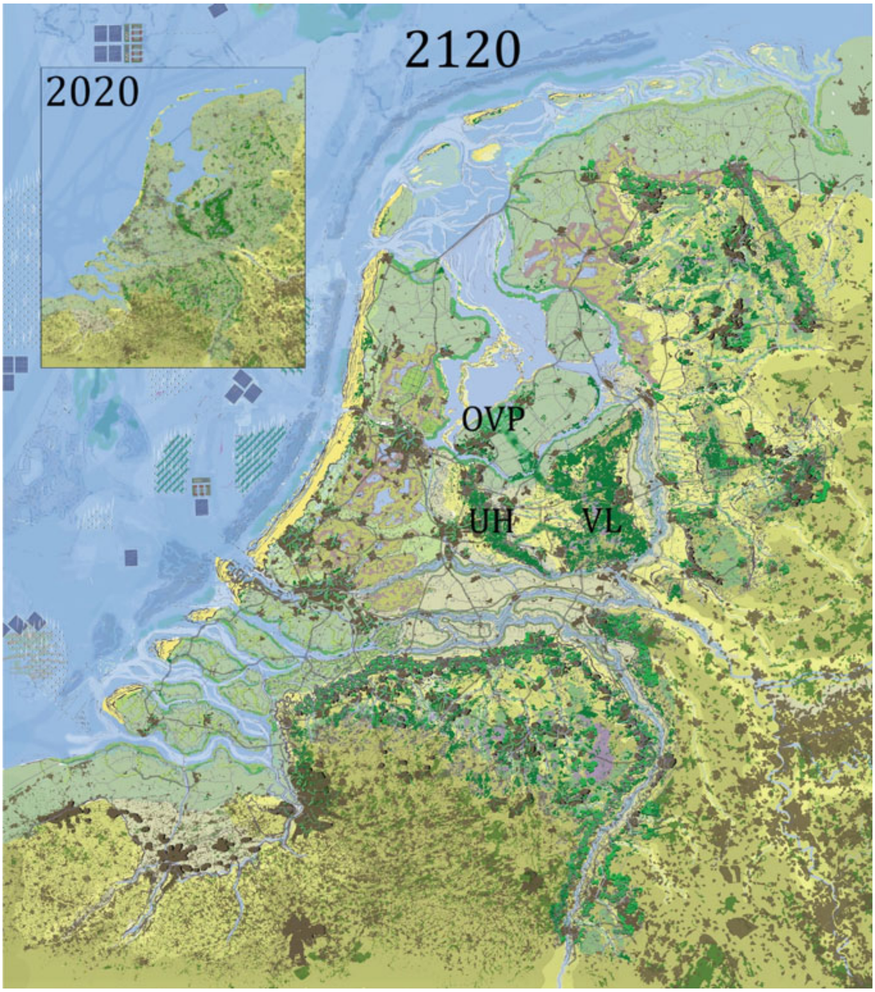

Fig. 2.2 The map of the Netherlands in 2020 (insert) and the vision for the future in the Netherlands in 2120 (Baptist et al. 2019), with some additional corridors added by H. Jansman, illustrating better connection between cores of nature areas: Oostvaardersplassen (OVP), Veluwe (VL) and Utrechtse Heuvelrug (UH)

human interest due to the absence of public infrastructure and agricultural lands in the area. Natural processes were the main driver of the ecosystem. Therefor the Oostvaardersplassen is, together with Yellowstone National Park, seen as one of the most illustrative examples of rewilding (Jepson and Blythe 2020; Flannery 2018). If I refer in this chapter to the Oostvaardersplassen I refer to the period before 2018 in which natural processes were dominating the development in the ecosystem. Since 2018 management has changed from reactive management (only shooting animals that are in a very poor condition and no longer capable of surviving the week) to proactive management (culling of deer in prime condition), similar to the management at the Veluwe. The change in management was based on a management advice by Van Geel et al. (2018). The commission concluded there was a lack of public support due to the high number of starving animals in winter, and conflict with Natura 2000 goals due to overgrazing by the large number of ungulates. As a result of the changed management, that winter more than 1700 red deer were shot to reduce the population size. In November 2019 a court decision stated that the shooting of red deer had to stop. The court ruled that the management was not sufficiently motivated and that the management advice report by Van Geel et al. (2018) was ecologically inadequately substantiated (Schreuder and Bontjes 2019). Until 2018 numbers fluctuated around the carrying capacity, which was roughly between 2.500 and 4.000 individuals and mortality mainly due to starvation was on average ca. 25% per year. This winter mortality depended on competition with other grazing species in the reserve and climate conditions. Reproduction was affected by this competition as well, resulting for instance in not all hinds having a calf each year.

2.7.2 Current Population of Wolf in the Netherlands

In January 2019 the first wolf settled in the Netherlands after an absence of about 150 years. Conflict with humans and human interest had led to its eradication. Due to better protection within the European Union, conservation programs as Natura 2000 and abandonment of rural areas, wildlife, including wolves, are recolonizing former habitat. In 2000 the first pack of wolves was a fact in Germany, close to the Polish border. In 2018 there were approximately 100 packs and pairs of wolves in Germany and the distribution area was nearing the Dutch border (www.nabu.de). Since 2015 already more than 23 wolves have been visiting the Netherlands (www.wageningenur.nl/wolven), mainly from the Central European population, but 1 from the Alpine population as well. Some of them settled at the Veluwe and in 2019 and 2020 pups were born, forming the first Dutch pack.

Depending on habitat quality and prey density, wolf packs need about 150–400 km^2 for a territory. Currently most wolves in Central Europe find their territories in robust nature areas and less in human dominated agricultural areas. The reason for that is probably the potential conflict between wolves and humans and livestock. Due to long term persecution wolves probably have learned to keep a safe distance to humans. Although wolves are strictly protected within the European Union, illegal poaching is still a common cause of death for wolves (Liberg et al. 2012). If a wolf forms a serious threat to humans or specializes on livestock and frequently kills well protected livestock, dispensation might be given to remove that wolf by killing it (IPO 2019).

2.7.3 Predator-Prey Relation Between Wolf and Red Deer

Large ungulates like deer are the most prominent food item for wolves. Wolves and deer have evolved together which resulted in behavioural and morphological modifications. Although predation of deer by wolves seems at first glance the most dominant impact of wolves on deer, this is not the case. The presence of wolves results in a change in behaviour by deer. Deer can change the group size and avoid certain areas to reduce the risk of predation. This is called the landscape of fear (Van Ginkel et al. 2019; Jepson and Blythe 2020). As a result there is more structure in grazing density which is good for diversity and vegetation growth. Wolves can also influence the number of mesopredators like coyotes or jackals, which might be beneficial for species that are eaten by coyotes or jackals. Altogether carnivores like wolves have a dominant top down regulation impact, which results in more stable and healthy ecosystems (Atkins et al. 2019). This has been well studied in Yellowstone national park, were wolves were introduced since 1995. Before the return of the wolf, deer numbers had increased enormously, resulting in overgrazing of the landscape. After the return of wolves, the deer population was predated on by wolves and as a result deer avoided dangerous areas. This led to a lean and mean deer population. Although ecosystem processes are very complex and many aspects have to be taken into account, like climate change, forest fires, increase of bears and decrease of coyotes, the positive effect of the return of wolves to this ecosystem and its biodiversity seems impressive (Smith et al. 2016). Since wolves are fiercely territorial and claim large areas, overhunting of their prey populations in natural conditions never takes place.

For a single large nature area the MVP for red deer was calculated to be around 4.000 individuals. For subpopulations with sufficient mutual dispersal and gene flow this was 400 individuals (Van der Grift et al. 2018). Thus it can be concluded that even the largest nature areas in the Netherlands doesn't hold a population large enough for long term survival. The genetic diversity was studied as well and found the population in the Oostvaardersplassen to be more diverse than the Veluwe population (De Groot et al. 2016). In deer from the Veluwe, parts of the genome showed hardly any variation, which is a sign of genetic drift or inbreeding (de Jong 2018). This could be the result of both historic management choices like introductions and restocking, but it could also be caused by current management strategies (proactive versus reactive), since these strategies differ largely. At the Oostvaardersplassen random mating is much easier, due to the absence of barriers in the reserve. With not all females having a calf each year, it is likely that only the most fit animals participate in reproduction which is a strong evolutionary driver for selection and adaptation. At the Veluwe there is still some level of habitat fragmentation. Also, by randomly culling approximately 50% of the population each year, it is questionable if random mating is still possible. Fact is that the population is kept much lower than the carrying capacity, so there is hardly any mutual competition for resources. As a result, all hinds participate in reproduction so there is no clear selection on fitness from that perspective. Therefore it is questionable if adaptation to for instance climate change, as recently shown in the red deer population on Rhum island, is possible in intensely managed populations like the one at the Veluwe.

Stokland (2016) mentions that a MVP for wolves should be 800 individuals in a closed population or 200 in a subpopulation with mutual exchange of individuals. As a small country, it's not likely that the Netherlands will have the capacity to hold 800 wolves. Even 200 wolves is a challenge. Wolf populations are a good example of a species that needs large areas and therefore are expected to cross borders. The Dutch wolves will always be part of the Central European population and they rely on dispersal for the long term viability. Compared to deer, wolves are more agile and a simple fence does not easily stop their migration. Wolves might include human cultivated areas in their territories. So it is less easy to avoid human-wolf conflict than it is to do so for human-deer conflict which can be averted with fences.

2.8 The Netherlands in 2120

The solution for viable ecosystems in the Netherlands and vital populations of red deer and wolf is the Core, Corridor and Carnivore approach in combination with more room for nature. Currently about 13% of the Dutch territory is protected as nature, more than half of which consists of large waterbodies like IJsselmeer and Markermeer. If the Netherlands wants to meet the Aichi biodiversity targets (2010) then it should protect 17% of its land area and 10% of its water area as nature reserves before 2020. Technically this means a doubling of the current size of terrestrial nature areas. If the Dutch landscape is rearranged in a smart way, then it is possible to enlarge the current nature reserves, forming more robust cores of nature. Next, those cores need to be connected via corridors, not only nationally but internationally as well, allowing for transboundary migration of species. If around these cores and corridors buffer zones are created which are extensively managed, for instance nature-inclusive agriculture, or forest for the use of CO_2 buffering or wood production, then conflicts between nature and human interest are less prone in comparison to intensive agriculture situated next to nature reserves. Certain species, such as meadow birds, might even benefit from an extensive level of management like nature-inclusive agriculture. If recreational activities and game management are concentrated in these buffer zones rather than in nature reserves, animals will be much more disturbed by humans in the buffer zone and therefore perceive this zone as scary and probably avoid it more. By doing so, recreation and hunting mimics predator behaviour, resulting in a landscape of fear. The areas with industry and intensive agricultural management as factory farming should best be positioned in areas with less biodiversity value and not neighbouring nature reserves. Finally there should be a good system to provide preventive measures to avoid conflict with wildlife. If that is not sufficient, there should be funding for unforeseen damage by wildlife. This is of importance if we want to coexist with (large) animals that due to their long distance travel potential might show up in areas with intensive human use (Bekoff 2014). In the cores natural processes will be the dominant driver. On the edges with intensive human use, mitigation and management focussed on conflict avoidance will be more dominant.

A vision of how the Netherlands could look like in the future if we allow more room for nature and natural processes was recently created by Baptist et al. (2019; Fig. 2.2). According to the authors, this map illustrates a version of the Netherlands in 2120. The vision is based on a number of criteria: for example, it had to deliver an optimal outcome for the biodiversity, because only then can the country fundamentally thrive. And they had to work as much as possible with solutions in which there is a big role for natural processes. The result is a map of what is possible, i.e. feasible and realistic when future choices on the use and lay-out of the Netherlands are based on understanding natural systems and processes. In order to better connect three major nature areas in the centre of The Netherland, I added two corridors to this map. A corridor connecting the Oostvaardersplassen with the Veluwe and one connecting the Utrechtse Heuvelrug with the Veluwe.

This approach allows for healthy populations of red deer, due to more space and better (seasonal-) migration between cores. Furthermore, their numbers do not need to be managed dominantly by management culling, allowing for more natural processes in the population. Wolves will be able to easily move nationally and internationally via the corridors, allowing for sufficient dispersal and gene flow in their population. The top-down forcing effect of wolves in the nature reserves allows for more stable ecosystems.

2.9 Change

In order to achieve this vision, we really need to change. Change our unsustainable way of living and change our way of thinking with respect to nature, natural processes and our position in relation to other species. In my opinion we humans are not superior, just different from other species. Human-wildlife conflict is in fact most of the time a conflict between opposing human values: what do you consider nature? What is the position of humans in relation to nature? Etc. We need a value-reorientation. Western societies have alienated from what nature is, natural processes (for instance seasons of food scarcity, mortality, only the fittest individuals participating in reproduction), and the feeling that we are part of nature and therefore depend on a stable ecosystem on planet earth. Rewilding not only nature, but our minds as well, is in my opinion a necessity. Albert Einstein already said: “We cannot solve our problems with the same thinking we used when we created them”. In my view, our problems, addressed in the first paragraph, are great and therefore there is an urgency for sustainable leadership. We know what is good for us and for biodiversity. But the human mind never needed to evolve in dealing with these challenges, since during most of the history of our species, we were only a minor player in the ecosystem. Nowadays, however, the human population growth curve of the last centuries shows an exponential growth and therefore corresponds very well with that of a plague species. Furthermore, our footprint is still increasing. Currently there is a large imbalance between how fast we consume resources and generate waste, and how fast nature can absorb our waste and generate new resources. The food system is also a major problem. The cost of ecological degradation is not considered in the price we pay for food, yet we are still subsidizing unsustainable fisheries and agriculture. From an ecological point of view, the key solution is managing our human population number and our livestock numbers. But that is quite a taboo topic and difficult to achieve in the short term. We at least need to adapt to a sustainable way of living and co-exist. How can we live in harmony with our fellow species on planet earth?

2.10 Further Reading

In this chapter I have presented many topics and addressed them briefly. In this book, some of these topics are discussed in more detail. Firstly, regarding saving more space for nature one can think of many options like land sparing (for instance by factory farming) versus land sharing (for instance by nature-inclusive agriculture); see the chapter by Hidde Boersma. Another interesting take on this issue regards the switchover from large scale livestock farming and meat consumption to cultured meat as described in the chapter by Cor van der Weele. Secondly, with regard to bringing back top-down forcing in ecosystems, one of the more controversial options is ecological replacement like back breeding, taxon substitution and de-extinction. Christopher Preston in his chapter discusses the speculative ethics' that has arisen around these technologies as gene reading, gene synthesis, and gene editing. Further it is often argued that we "owe it" to species driven to extinction "to bring them back." Jennifer Welchmann discusses whether justice can really require us to make restitution for anthropogenic extinctions. Thirdly, coexistence, in particularly with large carnivores like wolves can be a challenge. The chapter by Martin Drenthen discusses the dualistic idea that culture and nature are two strictly separated realms of reality, and how to learn and negotiate that the landscape as a space that is interpreted and inhabited by many different beings with whom we are always already communicating, even if we are not always aware of it. Mateusz Tokarski explains that environmental philosophy can provide conceptual tools easing the difficulties of cohabitation. He presents practical remarks regarding how environmental consolation could be practiced today in the context of difficult cohabitation with wildlife.

References

Atkins, J.L., R.A. Long, J. Pansu, J.H. Daskin, A.B. Potter, M.E. Stalmans, C.E. Tarnita, and R.M. Pringle. 2019. Cascading impacts of large-carnivore extirpation in an African ecosystem. *Science* 364: 173–177.

Baerselman, F., and F.W.M. Vera. 1989. *Natuurontwikkeling. Een verkennende studie* (Achtergrondreeks Natuurbeleidsplan; No. 6). 's-Gravenhage: S.D.U. Uitgeverij.

Baptist, M., T. van Hattum, S. Reinhard, M. van Buuren, B. de Rooij, X. Hu, S. van Rooij, N. Polman, S. van den Burg, G. Piet, T. Ysebaert, B. Walles, J. Veraart, W. Wamelink, B. Bregman, B. Bos, and T. Selnes. 2019. A nature-based future for the Netherlands in 2120. WUR report. https://doi.org/10.18174/512277. Accessed 23 March 2020.

Bekoff, M. 2014. *Rewilding our hearts: Building pathways of compassion and coexistence*. Novato: New World Library.

Blomqvist, D., A. Pauliny, M. Larsson, and L.A. Flodin. 2010. Trapped in the extinction vortex? Strong genetic effects in a declining vertebrate population. *BMC Evolutionary Biology* 10: 33.

Bonnet, T., M.B. Morrissey, A. Morris, S. Morris, T.H. Clutton-Brock, J.M. Pemberton, and L.E.B. Kruuk. 2019. The role of selection and evolution in changing parturition date in a red deer population. *PLOS Biology*. https://doi.org/10.1371/journal.pbio.3000493. Accessed 23 March 2020.

De Groot, G.A., G.J. Spek, J. Bovenschen, I. Laros, T. van Meel and H.A.H. Jansman. 2016. Herkomst en migratie van Nederlandse edelherten en wilde zwijnen: een basiskaart van de genetische patronen in Nederland en omgeving. Wageningen: Alterra, Wageningen-UR (Alterra-rapport 2724).

De Jong, J.F. 2018. *Genetic variation of wildlife in a human-dominated landscape: Genome-wide SNP analysis of wild boar (Sus scrofa) en red deer (Cervus elaphus) from the European continent*. Dissertation, Wageningen University, Wageningen.

Den Ouden, J., D.R. Lammertsma, and H.A.H. Jansman. 2020. *Effecten van hoefdieren op Natura 2000-boshabitattypen op de Veluwe*. Rapport 3031 Wageningen University and Wageningen Environmental Research.

Donaldson, S., and W. Kymlicka. 2016. Comment: Between wild and domesticated: Rethinking categories and boundaries in response to animal agency. In *Animal ethics in the age of humans*, eds. B. Bovenkerk and J. Keulartz. Wageningen: Springer.

Estes, J., J. Terborgh, J. Brashares, M. Power, and J. Berger. 2011. Trophic downgrading of planet Earth. *Science* 333 (6040): 301–306.

Faunabeheereenheid Gelderland (FBE). 2019. Faunabeheerplan Grote Hoefdieren FBE Gelderland 2019–2025. FBE Gelderland. https://www.faunabeheereenheid.nl/gelderland/PUBLICATIES.

Flannery, T. 2018. *Europe—The first 100 million years*. UK: Penguin Books.

Frankham, R., J.D. Ballou, and D.A. Briscoe. 2010. *Introduction to conservation genetics*. Cambridge, UK: Cambridge University Press.

Franklin, I.R. 1980. Evolutionary change in small populations. In *Conservation biology: An evolutionary ecological perspective*, ed. M.E. Souleand and B.A. Wilcox, 135–119. Sunderland, MA: Sinauer Associates.

Groot Bruinderink, G.W.T.A. 2016. Het Edelhert. In *Atlas van de Nederlandse zoogdieren* (deel 12), eds. S. Broekhuizen, K. Spoelstra, J.B.M. Thissen, K.J. Canters, and J.C. Buys. Leiden: Naturalis Biodiversity Centre and EIS Kenniscentrum.

IPBES. 2019: Link to the global assessment report on biodiversity and ecosystem services. https://ipbes.net/global-assessment-report-biodiversity-ecosystem-services. Accessed 23 March 2020.

IPO. 2019: Interprovinciaal wolvenplan Nederland. https://www.bij12.nl/nieuws/wolvenplan-goedgekeurd-door-provincies/. Accessed 23 March 2020.

IUCN Red list. https://www.iucnredlist.org/. Accessed 23 March 2020.

Jepson, P., and C. Blythe. 2020. *Rewilding—The radical new science of ecological recovery*. London: Icon Books Ltd., Omnibus Business Centre.

Keulartz, J. 2018. Rewilding. *Oxford Research Encyclopedia of Environmental Science*. January 2018.

Liberg, O., G. Chapron, P. Wabakken, H. Pedersen, N. Hobbs, and H. Sand. 2012. Shoot, shovel and shut up: Cryptic poaching slows restoration of a large carnivore in Europe. *Proceedings of the Royal Society B: Biological sciences* 279: 910–915. https://doi.org/10.1098/rspb.2011.1275.

MacArthur, R.H., and E.O. Wilson. 1967. *The theory of Island biogeography*. Princeton, NJ: Princeton University Press.

Mergeay, J. 2012. *Afwegingskader voor de versterking van populaties van Europees beschermde soorten*. Adviezen van het Instituut voor Natuur- en Bosonderzoek, nr. INBO.A.2832.
Miller, B., B. Dugelby, D. Foreman, C. del Rio Marinez, R. Noss, M. Philips, and L. Willcox. 2001. The importance of large carnivores to healthy ecosystems. *Endangered Species Update* 18 (5): 202–210.
Mills, L.S., and F.W. Allendorf. 1996. The one-migrant-per-generation rule in conservation and management. *Conservation Biology* 10: 1509–1518.
Nei, M. 2005. Bottlenecks, genetic polymorphism and speciation. *Genetics* 170: 1–4.
Ottburg, F.G.W.A., and C.A.M. van Swaay. 2014. *Gunstige referentiewaarden voor populatieomvang en verspreidingsgebied van soorten van bijlage II, IV en V van de Habitatrichtlijn* (WOt-rapport; No. 124). Wageningen: Wettelijke Onderzoekstaken Natuur & Milieu, Wageningen UR.
Primack, R.B., and A.A. Sher. 2016. *An introduction to conservation biology*. Sunderland, MA: Sinauer Associates.
Rockstrom, J., W. Steffen, K. Noone, A. Persson, F.S. Chapin, III, E. Lambin, T.M. Lenton, et al. 2009. Planetary boundaries: Exploring the safe operating space for humanity. *Ecology and Society* 14 (2): 32. http://www.ecologyandsociety.org/vol14/iss2/art32/. Accessed 23 March 2020.
Schreuder, A., and A. Bontjes. 2019. Rechter verbiedt afschieten edelherten Oostvaardersplassen. *NRC*, 12 December.
Shaffer, M. 1987. Minimum viable populations: Coping with uncertainty. In *Viable populations for conservation*, ed. M.E. Soule, 69–86. Cambridge, UK: Cambridge University Press.
Smith, D.W., R.O. Peterson, D.R. MacNultry, and M. Kohl. 2016. The big scientific debate: Trophic cascades. *Yellowstone Science* 24 (1): 70–71. https://www.nps.gov/yell/learn/yellowstone-science-24-1-celebrating-20-years-of-wolves.htm Accessed 23 March 2020.
Soulé, M.E., and R.F. Noss. 1998. Rewilding and biodiversity: Complementary goals for continental conservation. *Wild Earth* 8: 19–28.
Stokland, H. 2016. How many wolves does it take to protect the population? Minimum viable population size as a technology of government in endangered species management (Norway, 1970s–2000s). *Environment and History* 22: 191–227.
Svenning, J.C., B.M. Pil, C. Pedersen, J. Donlan, R. Ejrnæs, S. Faurby, M. Galetti, D. M. Hansen, B. Sandel, C. J. Sandom, J.W. Terborgh, and F.W.M. Vera. 2016. Science for a wilder Anthropocene: Synthesis and future directions for trophic rewilding research. *PNAS* 113 (4): 898–906; first published October 26, 2015 https://doi.org/10.1073/pnas.1502556112.
Traill, L.W., C.J.A. Bradshaw, and B.W. Brook. 2007. Minimum viable population size: A meta-analysis of 30 years of published estimates. *Biological Conservation* 139 (1–2): 159–166, September 2007. https://doi.org/10.1016/j.biocon.2007.06.011. Accessed 23 March 2020.
Van der Grift, E., A. Schotman, H. Jansman, and G.A. de Groot. 2018. Uitplaatsing van grote grazers uit de Oostvaardersplassen: Een quickscan van potentiële uitzetgebieden. *Wageningen Environmental Research* (rapport nr. 2903).
Van Geel, P.L.B.A., P.J.M. Poelmann, and H.J. van der Vlist. 2018. Advies Beheer Oostvaardersplassen - Kaders voor provinciaal beleid - provincie Flevoland. Externe Begeleidingscommissie beheer Oostvaardersplassen.
Van Ginkel, H.A.L., D.P.J. Kuijper, J. Schotanus, and C. Smit. 2019. Wolves and tree logs: Landscape-scale and fine-scale risk factors interactively influence tree regeneration. *Ecosystems* 22: 202. https://doi.org/10.1007/s10021-018-0263-z. Accessed 23 March 2020.
Wilson, E.O. 1992. *The diversity of life*. Cambridge, MA: Harvard University Press.
Wilson, E.O. 2016. *Half-earth: Our planet's fight for life*. New York, NY: W.W. Norton and Company Ltd.
WWF. 2018. *Living planet report—2018: Aiming higher*, ed. M. Grooten and R.E.A. Almond. WWF, Gland, Switzerland. https://wwf.panda.org/knowledge_hub/all_publications/living_planet_report_2018/. Accessed 23 March 2020.

Hugh A.H. Jansman is a wildlife ecologist at Wageningen Environmental Research, the Netherlands. His research is focused on sustainable ecosystems and vital populations of wildlife. Topics are monitoring, population viability analyses, reintroductions, conservation genetics, telemetry, post-mortem examinations, coexistence and management. Current project include monitoring of wolves, conflict management of red deer, wild boar & geese and monitoring the status of the reintroduced population of otters. According to Hugh the formula "Wildlife management = 90% management of people & 10% biology" refers best to his field of work. He received his Master's title at the Medical faculty, University of Leiden, but decided to shift to ecology. More information can be found at https://www.wur.nl/en/Persons/Hugh-drs.-HAH-Hugh-Jansman.htm.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.