



Synthesis

## The values of wildlife revisited

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**ABSTRACT.** Wild animals are important worldwide because of the multiple values they represent for human societies. Different frameworks have been proposed to understand the values of wildlife from economic and noneconomic perspectives. Despite efforts from different disciplines to provide a holistic framework for the analysis of wildlife values, the focus is still based on the monetary value derived from market prices. Community-oriented approaches to wildlife conservation have an especially strong economic rationale because they depend on the economic costs and benefits that wildlife represents to local communities. However, purely economic approaches ignore that values are subjective and as such are perceived differently among stakeholders according to their social, economic, cultural, and ecological context. The lack of a holistic framework hinders the possibility to provide a clear and practical tool for the resolution of wildlife conservation conflicts and the identification of management options that maximize values. Based on a wide literature review, we propose a comprehensive wildlife value framework (WVF) incorporating the values of wildlife identified in the academic literature into the total economic value (TEV) framework. Costs associated with human-wildlife conflicts are also incorporated as well as subjective perceptions of values based on multidimensional well-being criteria. This work aims to provide a common structure within which different perspectives related to wildlife can be captured to inform multi-actor, multi-objective decision making related to wildlife management.

**Key Words:** *animals; benefits; costs; total economic value; values; wildlife*

### INTRODUCTION

Wildlife is important because of the multiple values it represents for human societies. It is a generic term to refer to all animals living in the wild (Cambridge Dictionary, <https://dictionary.cambridge.org/us/dictionary/english/wildlife>). Wildlife provides a very wide range of products and services that are used traditionally but also processed along value chains with varying degrees of industrialization, including meat, medicine, cosmetics, fur, fat, skins, and trophies (Alves and Albuquerque 2017, Saayman et al. 2018). In rural contexts, people depend on wildmeat (or bushmeat) to ensure food security, generate income, or consume as a festival food in special events to perpetuate traditions and cultural identity (Lescuyer and Nasi 2016, van Vliet et al. 2016, Alves and van Vliet 2018). Wildlife plays a key cultural role in certain societies, particularly for its use in traditional medicine (Mardiastuti et al. 2021), arts and crafts (Jiao and Lee 2021), and for spiritual purposes (Boakye et al. 2019). Wildlife products are also found in luxury markets across the world, often procured through illegal market chains; rhinoceros horns are used by Vietnamese businessmen as a signal of their social status (Truong et al. 2016), and reptile skins are used in the fashion industry in the USA (Sosnowski and Petrossian 2020). Living animals are increasingly valued in local, national, and international economies for animal testing in the biomedicine sector (Sivakrishnan and Anbiah 2021), pet trade (Siriwat and Nijman 2018, Altherr and Lameter 2020, Mandimbihasina et al. 2020), and as a niche market in the tourism industry (Mbaiwa 2017).

Chardonnet et al. (2002) published a paper titled “The Values of Wildlife” that was instrumental in highlighting the economic, ecological, and socio-cultural importance of wildlife. Based on the differentiation between consumptive values and nonconsumptive values of wildlife, the authors distinguished between the uses of

wildlife that imply their extraction from the wild (as whole or in parts) and those derived from living animals left in the wild. Their analysis purposely used a purely anthropocentric approach because according to the authors, values that could be interpreted in monetary terms were powerful for preserving wildlife (Chardonnet et al. 2002). Indeed, economic valuations are often useful in the context of community-oriented wildlife conservation efforts that depend on the economic costs and benefits that wildlife represents to local communities (Emerton 2002). The values of wildlife, proposed by Chardonnet et al. (2002), included concepts from the total economic value (TEV), which is the main framework used to classify ecosystem goods and services values (World Bank 2005). Total economic value has a strong focus on direct use of values of wildlife that is more tangible and therefore easier to digest for high-level decision makers (Chardonnet et al. 2002).

Since 1992, the Convention of Biological Diversity (CBD) has recognized multiple values derived from wildlife, namely intrinsic, ecological, genetic, social, scientific, educational, cultural, recreational, and aesthetic values (United Nations 1992). Indirect values that refer to the indirect support wildlife provides to humans, such as wildlife contribution to maintain carbon stocks, are taken into consideration in the TEV. The TEV also integrates the notion of intrinsic values related to a nonutilitarian value of biodiversity and option values related to the future use of resources for either direct or indirect use (Moran and Bann 2000). Intrinsic values relate to the values that people perceive from knowing that wildlife exists without ever using it. The notion of intrinsic value is consistent with the mutualism value introduced by the human dimensions disciplines (Manfredo 2008, Teel and Manfredo 2010), which recognizes two main value orientations toward wildlife: domination and mutualism. The domination value corresponds to a utilitarian vision whereby the resource

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shall be used and managed for the benefit of humans. Whereas mutualism sees wildlife as an extended family, deserving rights like humans (Manfredo 2008, Teel and Manfredo 2010).

Despite efforts from different disciplines to provide a holistic framework for the analysis of wildlife values, there is no framework that captures the full spectrum of perspectives on the benefits and costs of wildlife, and the focus is still based on the monetary value derived from market prices (Feddema et al. 2021). Moreover, available valuation frameworks applied to wildlife ignore that values are subjective, and as such they are perceived differently among stakeholders according to their social, economic, cultural, and ecological context. Ignorance about these differences in the assessment of values is at the heart of many conservation conflicts. The lack of a unifying framework that describes the range of values as measured in economic terms or as perceived by each constituency, hinders the possibility to provide a clear and practical tool for the resolution of wildlife conservation conflicts and the identification of management options that maximize total values taking into consideration all constituencies.

Based on a wide literature review, we proposed a comprehensive wildlife value framework (WVF) incorporating the values of wildlife identified in the academic literature into the TEV framework. The notion of costs associated with the coexistence of wildlife is also incorporated, as well as the subjective considerations to include social justice in decision making from a multidimensional well-being analysis (Narayan et al. 2000, Strong and Silva 2020). We proposed a methodology to apply the WVF to measure the economic values of wildlife and to assess how benefits and costs are perceived by different stakeholders, to design more effective and equitable approaches to conservation (Pagiola et al. 2004).

## THE WILDLIFE VALUE FRAMEWORK

The proposed WVF is based on the typologies of values offered by the TEV (direct, indirect, and option use-values; non-use/intrinsic values; Moran and Bann 2000) including the human dimensions of wildlife to illustrate that values lean more toward domination or mutualism positions. Direct and indirect costs of wildlife, based on the human-wildlife conflicts literature, are also integrated (Barua et al. 2013, Thondhlana et al. 2020) to derive the net benefit that stakeholders perceive from wildlife. The different values included in the WVF are presented, and a methodology to implement the framework is proposed to identify how different stakeholders perceive benefits and costs from different values. See Figure 1, adapted from United Nations 1992, Moran and Bann 2000, and Feddema et al. 2021.

### Direct use-values of wildlife

Use-values or instrumental values can either be direct or indirect. The direct use-values of wildlife provide direct benefits to humans. They can be materialized through subsistence and leisure activities in which individuals use the resources for consumption (e.g., food, medicines), recreation, and cultural expressions or for commercialization and generating monetary benefits, e.g., wildmeat trade (Moran and Bann 2000). Direct use-values are classified as consumptive and nonconsumptive. Consumptive use-values of wildlife correspond to the extraction of animals or

animal parts from the wild or animal breeding facilities (even if the animal is later released back into its natural habitat after parts extraction). Although the nonconsumptive use-values are based on animals left in the wild, even if they are temporarily caught without taking any parts. Examples of the different values are provided for illustrative purposes.

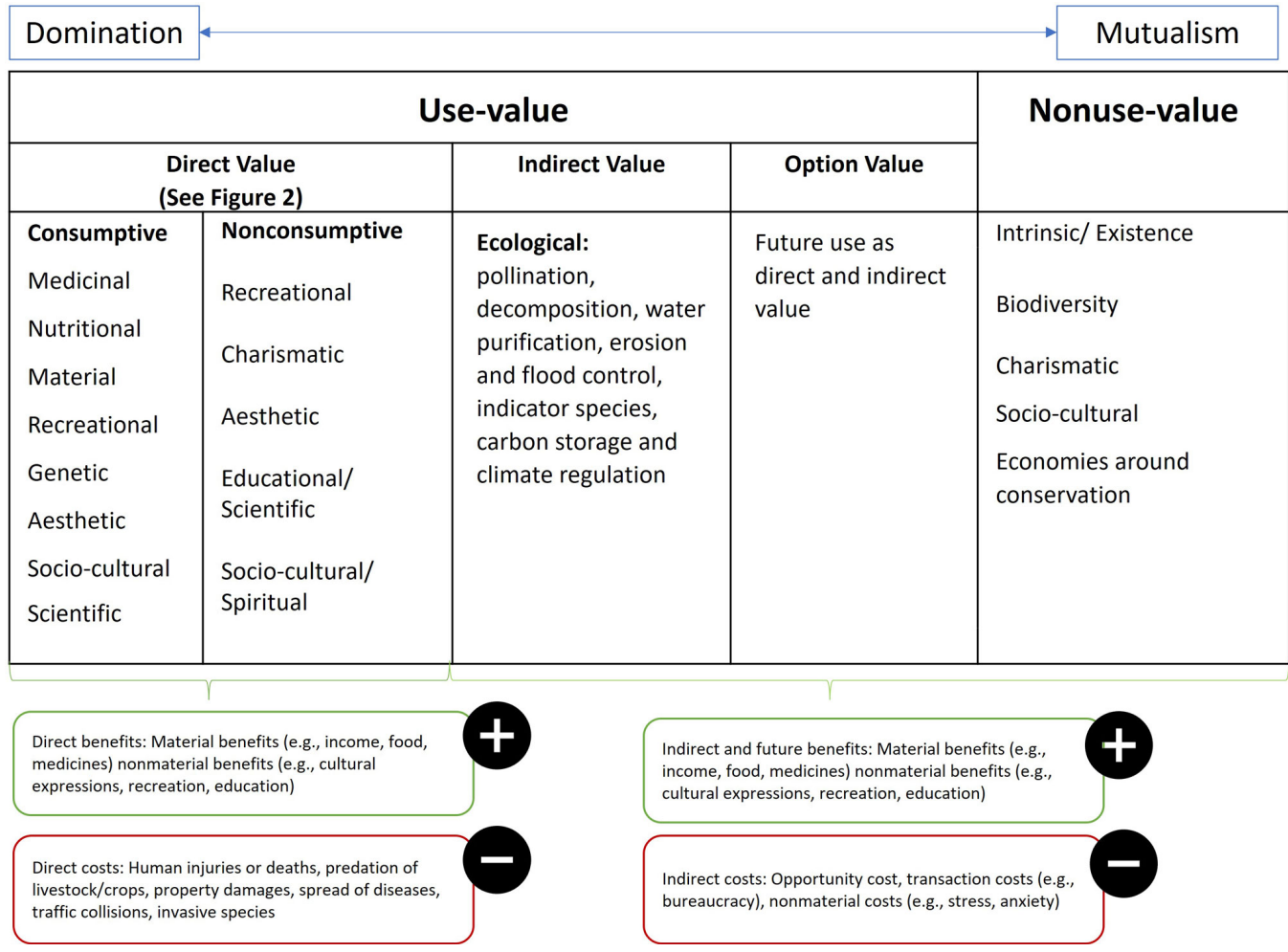
### *Consumptive direct use-values of wildlife (animals or animal parts extracted from the wild)*

The nutritional value of wildlife is closely linked to socio-cultural values in rural and urban contexts (Alves and van Vliet 2018). It can be materialized in basic and value-added products from both living and dead animals. In South America, the eggs of the seven species of river turtles (*Podocnemis*) as well as from Iguana (*Iguana iguana*) are commonly consumed by local communities (Alves and van Vliet 2018). From dead animals, wildmeat constitutes the principal source of nutritional products obtained from either hunting or animal breeding. In local contexts, wildmeat can have simple transformation processes associated with traditional practices of preservation. For instance, Indigenous hunters in the Amazon usually smoke or salt the meat after hunting (van Vliet et al. 2014). Wildmeat products can also have a higher level of value-added derived from more complex production processes or the combination of nutritional and recreational values. In South Africa, biltong is a traditional wildmeat that is processed into dried strips and seasoned with vinegar and spices. It may be obtained from recreational hunting, and it is consumed by the hunter and his/her family or friends (D'Amato et al. 2013, Taylor et al. 2016).

The medicinal value can be extracted from either dead or living animals and is generally derived from parts of the animal body (e.g., meat, blood, fats, venom, or placenta), products of its metabolism (e.g., secretions and excrements), or from nonanimal materials such as cocoons and nests (Costa-Neto 2005). Medicinal uses are often associated with traditional practices linked to socio-cultural values and can involve a basic level of preparation or processing mixed with other ingredients from plants or other animals (Alves and van Vliet 2018). In Nigeria, intestines from dead Nile crocodiles (*Crocodilus niloticus*) are used to prevent poisoning (Alves and van Vliet 2018); while in Asia, the musks from living male Himalayan musk deer (*Moschus chrysogaster*) are used to stimulate blood circulation, reduce inflammation, and relieve fever among other uses (Shrestha 1998). Along with traditional practices, wild animals are also used to produce high-value-added industrial medicines. For instance, toxins from animal poisons and venoms have a wide range of pharmacological uses (Bordon et al. 2020).

The genetic value of wildlife can be materialized by the creation of genetic resource banks to store germplasm (e.g., semen, eggs, and embryos) for use in animal breeding programs and scientific research (Holt et al. 1996). Genetic resource banks have been important for conservation. Animal species from diverse phenotypes and geographic origins are bred in captivity in North American zoos to maximize genetic diversity through a species survival plan (Wildt 2000). In animal breeding, gene modifications have improved food animal species and decreased environmental footprint as well as disease resistance (Van Eenennaam 2017). For example, in South Africa, private buffalo

Fig. 1. The wildlife value framework.



ranchers are regularly restocked with disease-free buffalos from Addo Elephant National Park to avoid genetic degradation of the population (Jager et al. 2020). In addition, the genetic value also has applications in research for the pharmaceutical sector in which animal models have helped improve the understanding of causes and progression of human genetic diseases and the discovery of therapeutic drugs (Simons 2008). This value can lean toward mutualism depending on the purpose of the activity. For example, a genetic bank for conservation is more mutualistic than the use of gene pools for commercial animal breeding. In conservation, genetic values can also be option values for future uses.

Aesthetic values related to consumptive values are materialized in artistic expressions such as works of art or handicrafts. The aesthetic value is also intrinsically linked to socio-cultural values. For example, animal parts such as scales and tusks are used to produce artisanal jewelry or handicrafts.

Material value, understood as the value materialized in raw materials, is found at artisanal and industrial scales in products

with a functionality for socioeconomic activities. At artisanal levels, animal parts such as bones and tusks have been used from ancient times to produce basic tools by Indigenous peoples. Guano, which is the accumulation of excrements, eggshells, and carcasses from seabirds and bats, is used as fertilizer because of its concentration of nutrients (Schnug et al. 2018). Material value also includes a variety of animal parts used as raw materials for the industry such as feathers for blankets and pillows, compounds for cosmetics and medicines, leather and fur for accessories and clothes, among others. In this sense, it is closely linked to other values with applications in industry, such as medicinal and nutritional values.

Recreational, socio-cultural, educational, and scientific values can be materialized in both consumptive and nonconsumptive uses. As an example of consumptive uses from recreational values, trophy hunting is a common activity practiced in many African countries. Tourists typically pay a large sum of money to select animals with exceptional physical attributes (e.g., large horns, tusks, body size) to hunt them as trophies, usually in the company of a hunting guide (Lindsey et al. 2007). Socio-cultural values are

also intrinsically linked to other values such as nutritional, medicinal, aesthetic, recreational, and material values. According to Booker (2019), culture is a key driver for the preference of wildmeat as a food choice. Similarly, wild animals are used in traditional medicines according to cultural beliefs. However, some consumptive use-values are not necessarily linked to other values, for instance, BaKota people in Northeast Gabon kill leopards and other spotted cats in ceremonial rituals but their meat is not consumed (Sassen and Wan 2006).

The scientific value in consumptive uses is related to the use of wild animals in pharmacopeia, for example, the use of African green monkeys in animal testing for polio vaccines in the early 1990s (Chumakov et al. 1991). Educational and scientific values can be materialized through the knowledge generated by studying and understanding wildlife collections or wild animals in captivity. Examples include the scientific, educational, and recreational values derived from ex-situ conservation strategies such as zoos, aquariums, and museums (Geda and Balakrishnan 2013).

#### *Nonconsumptive direct use-values of wildlife (animals in the wild)*

Nonconsumptive direct use-values include recreational, aesthetic/charismatic, educational/scientific, and socio-cultural/spiritual values. Nonconsumptive recreational values are intrinsically linked to wildlife tourism, catch and release activities, or wildlife photography. Wildlife tourism has been defined as the probability of positive encounters with wildlife for visitors while protecting the resource (Reynolds and Braithwaite 2001), and it is intrinsically linked to the aesthetic/charismatic values of a given species. Different activities can be experienced in both terrestrial and aquatic ecosystems such as safaris, bird watching, whale tourism, scuba diving, and snorkeling, among others. Catch and release is a popular practice in recreational fishing that consists of immediately returning the live fish into the water (Barnhart 1989). Other studies have reflected on the psychological or well-being value for humans because of the interactions with wildlife. Ecotourism and wildlife watching is beneficial to the human psyche by providing restoration from stress and fatigue (Curtin 2013). Brock and Perino (2017) found that people derive well-being through adopting a warden-type role toward wildlife, for instance, when feeding birds.

Nonconsumptive educational/scientific value can be materialized through the knowledge generated by studying and understanding wildlife in their environment. It is also related to recreational values, for instance, scientific tourism generates and disseminates scientific knowledge while it promotes touristic activities (Scientific Tourism Network 2019, <https://scientific-tourism.org/scientific-tourism/?lang=en>). Wildlife tourism also involves educational guiding experiences to learn about the species and their habitats aiming to promote in situ conservation. Socio-cultural/spiritual values are those that relate to animals represented in traditional myths and stories. For example, the pink dolphin (*Inia geoffrensis*) in Amazonian culture represents the figure of a handsome man that appears at night and seduces the girls before returning to the river at dawn, and it is thought to be the father of all children from unknown paternity (Craivalho 1999). These socio-cultural values can also be attached to recreational values, for instance, through the promotion of

cultural experiences and the narration of stories and myths during touristic expeditions. Religious and spiritual beliefs in some Indigenous and local cultures prevent consumptive uses of wildlife species associated with cultural values. For Wapishan people in Guyana, some wildlife species such as the Tapir (*Tapirus terrestris*) cannot be hunted because they are considered grandfather spirits (Henfrey 2002, David 2006).

#### **Indirect use-values of wildlife**

The indirect use-values of wildlife are those that generate indirect benefits to humans when wildlife provides ecosystem services that support economic or subsistence activities. Therefore, ecosystem services are acknowledged from a utilitarian and human-centric perspective because they indirectly benefit humans. For instance, pollinator species improve crop production thus contributing to food security and local livelihoods (Moran and Bann 2000, Potts et al. 2016). Flies, beetles, large scavengers (e.g., opossums, raccoons, vultures), bacteria, and fungi can provide decomposition services to humans through eating or decomposing carrion and waste (Mondor et al. 2012).

Some species provide services related to freshwater and marine ecosystems. Beaver wetlands filter compounds and human-caused pollutants, increasing water quality and reducing the costs of wastewater treatment (Thompson et al. 2020). Indicator species such as mollusks (particularly from the Bivalvia class) are often used to determine the existence and quantity of toxic substances in coastal and estuarine environments because of their capability to accumulate substances in their tissues (Marques 2008). Recent studies have also demonstrated the role of wild animals in mediating a landscape's capacity to store carbon; animals can increase or decrease rates of biogeochemical processes ranging from 15 to 250% or more. In the Serengeti savannah, for every 100,000 additional wildebeests that live within the ecosystem, carbon storage increases by 15% (Schmitz et al. 2018).

Although the benefits perceived through wildlife ecosystem services are indirect, they might become direct and more tangible for local communities participating in payment for ecosystem services (PES) projects. Direct economic benefits from PES can compete with socio-cultural and economic benefits from direct use-values (especially from consumptive uses) contributing to behavioral changes that are more compatible with conservation targets (Chen et al. 2020) or with nonconsumptive use-values. Similarly, the benefits perceived from PES might also represent compensation for the costs associated with human-wildlife conflicts. In Nairobi National Park, private landowners are paid per acre to support wildlife on their land by keeping it intact and unfenced, refraining from poaching, and protecting grazing areas. The payments have contributed to improving local livelihoods and attitudes toward wildlife (Davis and Goldman 2019).

#### **Option values of wildlife**

Another type of use-value included in the WVF is the option value. This value occurs when the preference is to use future resources rather than those in the present, with the expectation that better direct or indirect benefits will be obtained (Moran and Bann 2000).

The option value is consistent with the concept of sustainable wildlife management, which has been defined by the CBD as "the sound management of wildlife species to sustain their populations



and habitat over time, considering the socioeconomic needs of human populations” (CBD 2018:1). Sustainably managed wildlife can provide long-term contributions to local livelihoods (e.g., food security and income) while safeguarding human and environmental health (CBD 2018). Many wildlife conservation and sustainable use strategies are based on the idea of limiting or restricting current uses of wildlife to restore populations for future uses with increased benefits. As an example, a successful project in Cispatá Bay, in Colombia, recovered a threatened population of American crocodiles (*Crocodylus acutus*) by 376% in 13 years. The recovery was undertaken by local former hunters of the species to enable the use of the resource in the future. Regulatory changes were made in response to the recovery, and now local communities from the area are allowed to use the species in breeding programs for commercial purposes (Ulloa et al. 2016, Ulloa and Sierra 2016).

#### **Nonuse/intrinsic values of wildlife**

The WVF includes a category of nonuse-values meaning the opposite to direct, indirect use, and option values. Nonuse-values have been defined as the benefits that people perceive from knowing that biodiversity exists without ever using it. Under this definition, biodiversity has an existent or an intrinsic value (Kolstad 2000, Pascual et al. 2010, Nobel et al. 2020).

Existence value has been an important argument in ethical discussions advocating for ecocentric positions and supporting animal rights (Taylor 1987, Verhoog and Visser 1997). The intrinsic value is consistent with mutualism under the human-wildlife approach, and it is a justification for conservation goals (Sandler 2012). Some wildlife studies have addressed values from moral perspectives (Lute 2016) and emotions (Abidin and Jacobs 2019) to understand behaviors and attitudes toward wildlife beyond purely economic approaches. Intrinsic values might also outweigh economic values. For instance, some stakeholders may oppose sport hunting despite its economic benefits because they recognize the intrinsic value to individuals (Conniff 2014).

Benefits for humans from intrinsic values are more difficult to perceive because the value is in principle noninstrumental but can still generate huge indirect benefits. Conservation programs for wildlife may indeed mobilize a considerable amount of cash flow while supporting job creation and public funding within or around their conservation objectives. In that case, the intrinsic value of wildlife is instrumental in generating direct value. For example, the intrinsic value of biodiversity generates around US\$300 million annually from the World Bank (Reed et al. 2020). Developing and least developed countries receive important sums for wildlife conservation creating a whole economy around it. Lindsey et al. (2018) identified that protected areas in Africa receive a minimum of US\$381 million in funding annually. Although the aim is to preserve wildlife species for their intrinsic value, these protected areas are instrumental in market dynamics to obtain funds for their conservation.

Wildlife conservation has also been included as part of merchandizing strategies that aim to increase the trade of multiple products and services with the promise of investing a percentage of the revenues in conservation strategies. These strategies are linked to charismatic values. Flagship species such as elephants, pandas, and lions have been used as part of marketing strategies to raise conservation funds (McGowan 2020). An example of such strategies

is the conservation plan for the three-banded armadillo (*Tolypeutes tricinctus*). The FIFA Football World Cup 2014 Brazil mascot was funded through a share of the merchandising sales of the World Cup. The armadillo has been the most successful mascot in the history of World Cups (Good et al. 2017) with the merchandising strategy also raising millions of dollars for the protection of the armadillo and its habitat. The discussion between intrinsic and instrumental values has been taken one step further with the proposal of establishing cultural species economies based on the charge of royalties for using animal symbols in fashion, sports, and logos intended to fund the conservation of such species (Good et al. 2017).

#### **Wildlife costs**

Although wildlife has multiple values that represent economic and social benefits (positive effects) for human societies, it also has important costs (negative effects) associated with human-wildlife interactions. The WVF proposed in Figure 1 represents the costs derived from the intrinsic values of wildlife because costs are perceived for the mere fact that wildlife exists independently of its use by human populations. The literature on human-wildlife conflicts has identified multiple costs of wildlife, which are divided into direct and indirect costs.

#### **Direct costs of wildlife**

Direct costs have been the most studied in literature because they are the most visible. These are derived from human material losses often caused by the predation of livestock, crop and property damages, human injuries and deaths, the spread of diseases, the spread of invasive species, and traffic collisions. The aggregated costs can represent significant losses for people living near wildlife. For instance, annual losses because of elephant crop-raiding in the Meru National Park in Kenya have been estimated at US\$129,331 (Sitienei et al. 2014). Regarding livestock predation, farmers in the Serengeti have reported that the cost equals 19% of their annual cash income. In Bhutan the attacks on livestock by carnivores cost over two-thirds of farmers’ annual cash income (McManus et al. 2015). Although attacks on humans are less common, nearly a thousand people were attacked by African lions in southern Tanzania between 1990 and 2010 (Packer et al. 2019) and around 1.2 million deaths were caused by snake bites in India between 2000 and 2019 (Suraweera et al. 2020). Although wildlife provides ecosystem services, it can also create negative impacts. For example, in the Chobe River in Botswana elephant dung significantly contributes to the presence of *E. Coli* concentrations in the dry season (Fox and Alexander 2015).

#### **Indirect wildlife costs**

Indirect costs are generally invisible but have been increasingly recognized in wildlife studies. These are related to indirect losses or opportunity costs to avoid direct costs generated by wildlife, e.g., the time used to protect or guard livestock and crops against predation at night. In some parts of Asia and Africa, the guarding is done by men at night and by children during the day, causing fatigue and increased alcohol consumption among adults and a drop in school attendance by teenagers and children (Barua et al. 2013).

Indirect costs can also be derived from transaction costs associated with the bureaucracies and obstacles in the processes to claim economic compensations for damages (Barua et al. 2013).

Nonmaterial or intangible costs have also been recognized, including indirect effects, such as negative feelings (e.g., trauma, depression, fear, and anxiety), loss of school attendance, and poor child development, e.g., when children undertake more household responsibilities because of the loss of a parent (Barua et al. 2013, Thondhlana et al. 2020). In the Indian Sundarban, over 50% of widows from victims of tiger and crocodile attacks suffered from poor physical and mental health aggravated by the inability to recover the body of the victim in 95% of cases (Barua et al. 2013). Also, in India, extreme crop-raiding by elephants has resulted in the abandonment of traditionally cultivated fields that led to the disruption of lifestyles, families, and social bonds (Thondhlana et al. 2020). Although less attention has been paid to nonmaterial costs, some studies show that these can aggravate the nontolerance toward wildlife by people living in proximity (Kansky et al. 2016, 2021).

Costs due to human-wildlife conflict have a higher impact on vulnerable stakeholders because they tend to aggravate preexisting poverty conditions (Jadhav and Barua 2012). Similarly, Ogra (2008) identified that some costs have a heavier impact on women. As an example, in the Garhwal region of the Himalayan state of Uttarakhand, India, women must fetch drinking water from a hydroelectric canal until pipes damaged by elephants are repaired. Women occasionally fall into the fast-moving water being at risk of drowning. Ogra (2008) also identified that nutritional deprivations because of human-wildlife conflicts have stronger impacts on women because they tend to eat smaller portions to provide more food to their relatives.

Economic values derived from wildlife are perhaps the main driver for local communities to tolerate their associated costs (Bagust 2010). Policies and regulations are relevant factors but have less influence in the context of poverty. Mutualistic perspectives linked to intrinsic or charismatic values are also crucial to understand how people react to wildlife costs and policy interventions, especially in urban contexts. Policy decisions on human-wildlife conflict often respond to public perceptions and emotions toward wildlife, especially when there is a charismatic value. Public perception has resulted in the reversal of decisions on lethal control, such as the culling of overabundant koalas in southern Australia (Bagust 2010, Drijfouth 2022). When intrinsic values are recognized in individual specimens, they may come into conflict with economic and even ecological values associated with the conservation of species and ecosystems. Because of this, purely economic perspectives may not be sufficient to manage wildlife costs. Although in contexts in which people constantly have interactions with wildlife, emotions or attitudes toward animals are highly influenced by negative human-wildlife interactions, which are also correlated with direct and indirect costs (Vaske and Needham 2007, Sponarsky 2015).

## STEPS TO IMPLEMENT THE WILDLIFE VALUE FRAMEWORK

A seven-step methodology is proposed to implement the WVF in wildlife related interventions aimed at identifying how the different stakeholders perceive the different values of wildlife and assess the benefits and costs they derive from wildlife, rather than assessing the TEV of a species. At a macro level, the framework can be applied by wildlife managers and decision makers (e.g.,

wildlife authority) to anticipate conflicts, identify interventions that maximize values for all constituencies, and assess the impact of an intervention or formulate compensation policies. It can also be applied by local communities to understand how benefits and costs are perceived within the community to implement benefit sharing schemes. The operationalization of this framework involves the participation of relevant stakeholders in each of the steps.

### Step 1: Identify a wildlife species or a group of species of interest

In wildlife management or conservation initiatives, the focus is rarely on all existing wildlife but rather on one species or on a group of species, which needs to be defined in advance to narrow the analysis. For example, in wildmeat related interventions, the focus is on all terrestrial mammals, birds, amphibians, and reptiles. The focus could also be on aquatic wildmeat, which often refers to mammals living in aquatic ecosystems (e.g., whales, dolphins). Or, the focus could be on a specific species, for example, the conservation of the *Spinus cucullata*, an endemic bird living in Venezuela and Guyana and threatened by the international pet trade. This identification should be done in accordance with what relevant stakeholders suggest, thereby ensuring that the analysis covers the species, list of species, or group of species perceived as important for each stakeholder group. Therefore, the proposed steps 1 and 2 are intertwined and should be conducted in a coordinated manner. In case of a multispecies intervention, the prioritization of species needs to reflect the interests or concerns of all stakeholders.

### Step 2: Identify stakeholders

Values of wildlife are perceived differently among stakeholders according to their social, economic, cultural, and ecological context. For example, traditional African societies place a higher spiritual value on their local wildlife than do western societies (Sifuna 2012). Urban populations usually place more mutualistic values on wildlife than do rural people (Alves and van Vliet 2018). Identifying all possible stakeholders that may benefit from wildlife or bear its costs, is important to ensure that the whole constituency is considered in the analysis. The identification may be carried out following a stakeholder analysis and a classification according to influence and interest. It is useful to keep in mind the generic list of values presented in Figure 1 to avoid ignoring stakeholders that may be invisible because they would be linked to less tangible values. The stakeholders may be segmented based on broad categories (such as local communities, NGOs, governmental institutions) or be very specific to incorporate differences in gender, ethnic origin, age groups, etc.

### Step 3: Identify and measure values and costs

The list of values of wildlife and their quantification should ideally be done with each stakeholder identified in step 2 using participatory approaches, such as group discussions. Appendix 1 presents examples of metrics that can be used to measure different types of values. It does not pretend to be comprehensive for all the values and all the possible associated valuation metrics but rather provides examples for implementation. Each effort to operationalize the framework may identify appropriate alternative valuation approaches. We acknowledge that measuring all value types within a social ecosystem would require a considerable amount of time and resources, therefore, we

suggest a prioritization of values according to the views of stakeholders and the purpose of the assessment.

Direct use-values are easier to measure because they often respond to market dynamics. However, indirect option and nonuse-values are more complex. These are often measured through contingent valuation methods to estimate the willingness of people to pay for the specific value. Contingent valuation has also been applied to complement direct use-values such as recreational. When assessing for instance the value of certain species within a wildlife park, market value is useful, but it is not enough to measure the proportion of the value allocated to a specific species. For this, contingent valuation along with choice experiments may be applied to compare the willingness to pay in different scenarios with and without the species. Mustika et al. (2020) used contingent valuation to estimate the proportion of tourist expenditures attributable to sharks in an Indonesian park, based on hypothetical tourism days lost if sharks were absent from the study area.

Contingent valuation has been the main method applied to value ecosystem regulating services. However, in the case of wildlife, it is a challenge to assess the specific contribution of a species within the ecosystem. Ishwar (2016) used a cost-based valuation approach to estimate the cost of replacing the decomposition service provided by vultures in their absence. Recent studies have estimated quantities of carbon capture services provided by wildlife species such as wildebeests and elephants using spatial models (Schmitz et al. 2018, Winton and Richardson 2019, Berzaghi 2021). The estimation of carbon storage by specific species might allow the quantification of these services in carbon markets providing an economic value. Berzaghi (2021) identified that if African forest elephants were protected, their services would be worth US\$35.9 billion across tropical Africa.

Contingent valuation has been used for option values as the values reflecting a willingness to pay to conserve the option of making use of the resource in the future even though there is no current use (Pearce 2001). The option value can also be seen as a trade-off of use-values to analyze the benefits of conservation for future uses. For instance, a game reserve manager can decide either to allow the current hunting of certain species or to recover the population with the expectation of higher returns in the future. For this kind of decision, it is common to use the expected net present value (NPV) approach because it considers the difference between the expected aggregate costs and benefits of carrying out a project in present value terms (Traeger 2014). For nonuse-values, contingent valuation is also the main method. However, conservation is linked to market dynamics and generates economic revenues in the form of job positions, international cooperation cash flows, and marketing campaigns among other benefits. Regarding costs, market-based approaches are more useful because costs are often related to market prices. For instance, costs of livestock and crops predated are based on market prices, and costs of bureaucracy transactions are based on wage hours spent in the process.

Values might be ranked differently for some stakeholders even if they are quantified with similar economic benefits. For instance, for local communities, direct use-values might be more important than indirect values even if they are estimated to provide a higher

economic value (e.g., in the case of carbon storage). Some socio-cultural values might also be perceived as more important than direct use-values. For example, when a species is protected because of spiritual beliefs, the socio-cultural value might be perceived as higher than the economic benefits of commercial hunting. Subjective considerations may also have an impact on the tolerance of costs according to charismatic or mutualistic values and emotions toward animals. This depends on each context, thus a participatory approach, combined with qualitative methods such as value scales, might be incorporated into the framework to provide a more subjective perspective. Subjective factors might be applied to both values and costs according to the perceptions of the different stakeholders.

#### **Step 4: Identify intervention scenarios**

This step consists of identifying possible interventions related to wildlife based on the vision and goals expressed by the different stakeholders identified in step 2. The range of possible interventions varies according to each context but may relate to the use and trade of wildlife, its conservation, the reintroduction of wildlife species or the control of populations. In fact, this framework can be used in any situation in which there is a need to understand if a management intervention may help to maximize values across different stakeholders or may undermine values that are important for a given group.

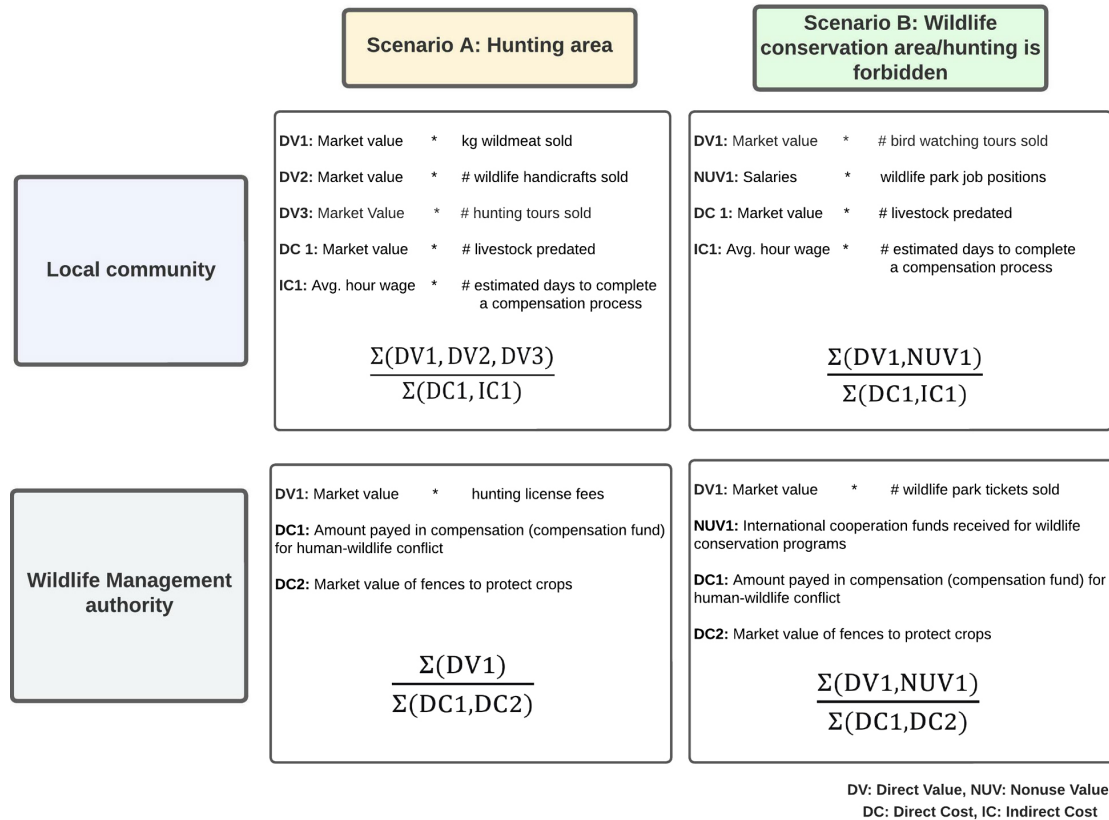
#### **Step 5: Identify winners and losers in different scenarios**

Understanding costs and benefits among stakeholders for different scenarios is a key step to designing more equitable benefit-sharing schemes. All relevant costs and benefits for each stakeholder in a scenario can be computed to measure trade-offs between management scenarios and specific interest groups (Fig. 2). Although the estimations of the values should be taken with precaution, the framework can serve to visualize scenarios that optimize benefits for all stakeholders or to calculate the opportunity cost of a scenario with respect to another. Some management interventions may increase a given value of interest to a specific stakeholder but totally undermine other values that are important for different stakeholders. Figure 2 presents an example of the assessment of values that two stakeholders may perceive in different scenarios. Although the stakeholders lose some consumptive use-values in scenario B because of the hunting prohibition, they also perceive new values with the establishment of the conservation area. The analysis allows the comparison between new and lost values to identify winners and losers and to incorporate compensation measures if required.

#### **Step 6: Identify vulnerable groups**

Costs have heavier impacts on vulnerable groups and tend to aggravate poverty conditions. Values are also perceived differently by stakeholders according to economic dependences (e.g., when the main source of income is from hunting or tourism), on the availability of protein sources from wild animals (e.g., wildmeat is a main protein source), as well as socio-cultural factors (e.g., traditional practices and spiritual beliefs). Wildlife values are more linked to Indigenous peoples' livelihoods and may have stronger impacts in rural than in urban populations. Because of this, it is important to apply subjective considerations to identify which groups are more dependent on wildlife and more vulnerable to their costs. Such assessments would provide information on which groups would perceive higher impacts on a potential

**Fig. 2.** Perception of values and costs for different stakeholders in two scenarios.



intervention and identify risks of poverty or vulnerability aggravation. Appendix 2 presents a tool to implement surveys or focus groups to assess the vulnerability of stakeholders, considering subjective values and costs linked to multiple dimensions of well-being. Surveys can be applied along with the identification of values from step 3, but their analysis would require the consideration of different scenarios after steps 4 and 5.

According to the intervention scenario proposed in Figure 2, “hunting is forbidden” Figure 3 presents an example of an analysis applied to the local community or groups within the community. The analysis identifies potential dimensions of well-being affected by the proposed measure using the inputs from Appendix 2.

**Fig. 3.** Well-being dimensions affected by the proposed intervention.

Well-being dimension	Associated values	Potential impacts under scenario B	Impacts by gender
Food security	Nutritional value (wildmeat is a main source of protein intake)	Loss of protein intake, less nutritional diversity	Women are more affected because they tend to provide more food to the children (see Ogra 2008)
Material well-being	Income from use-values (wildmeat trade is a main source of income)	Loss of household income	Men are more affected because hunters are usually men
Social well-being	Socio-cultural values (hunting is part of the local culture and promotes social relationships)	Stigmatization of hunters, loss of social status	

### Step 7: Decision making

Steps 5 and 6 provide information and tools for decision makers to assess the potential implications of wildlife interventions. The example from Figure 2 offers a broader vision of the stakeholders under different scenarios to assess trade-offs and opportunities to maximize values. Whereas the example from Figure 3 provides more details on how the proposed intervention would affect the situation of vulnerable stakeholders, bearing in mind dependence on wildlife values and vulnerability to costs. Measures can be implemented to reduce imbalances among the stakeholders such as compensation schemes for the foregone opportunity cost of some values or incentives to induce positive choices of behavior (Thuy et al. 2013). Social equity considerations shall be incorporated to ensure that poverty and vulnerability conditions are not aggravated because of the intervention.

### CONCLUSIONS

A comprehensive framework (WVF) is proposed to analyze the broad spectrum of values that wildlife represents to human societies and to describe the steps that allow a comparison of benefits and costs perceived by different stakeholders under different management interventions. This framework can have several possible applications and may support decision making with regard to any wildlife related intervention, including hunting management, wildlife conservation, wildlife reintroduction, culling, wildlife extraction for processing and trade, etc.



This framework explicitly acknowledges that successful wildlife conservation is dependent on its capacity to generate benefits among a diversity of stakeholders that may not equally benefit from the presence of wildlife. In addition, this framework accounts for the costs associated with human-wildlife interactions and the opportunity costs derived from conservation and wildlife management interventions (Emerton 2002). As such, it is a useful tool to represent net benefits that are closer to the realities experienced in each social ecosystem.

A participatory process linked to the application of such a framework represents an opportunity for stakeholders to visualize the values that others place on wildlife (particularly when less tangible values are involved) and can therefore be used to facilitate negotiation processes and support decision making based on the values and beliefs of the various constituencies. The implementation of multidimensional well-being criteria incorporates notions of social justice into the framework to identify the risks that wildlife management interventions may pose on vulnerable communities, which are more dependent on wildlife values and more vulnerable to its costs. We emphasize the need to incorporate more holistic approaches that combine both quantitative and subjective perceptions on wildlife values to enhance decision making.

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#### Data Availability:

*Data/code sharing is not applicable to this article because no data code were analyzed in this study.*

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## Appendix 1. POTENTIAL VALUATION METRICS FOR EACH TYPE OF VALUE

TYPE OF VALUE	APPROACHES	METRICS
DIRECT USE-VALUES (DV)		
Nutritional	Market-based approaches	Market value*kg wildmeat sold Market value*kg wildmeat (Nunes et al (2019) multiplied body mass by a factor of 0.6 assuming the total weight of fresh edible meat) Market value*# wildmeat dishes sold (restaurant) Market value*# of eggs sold Opportunity cost if wildlife was not available (e.g., market value *kg of the most affordable available alternative source of protein)
Material	Market-based approaches	Market value*# wildlife handicrafts sold Market value*# products derived from animals (e.g., leather, fur)
Recreational	Market-based approaches, Contingent valuation, choice experiments	Market value*trophy hunting touristic plans sold Market value*# wildmeat dishes/handicrafts sold to tourists (See Jacinto-Padilla et al. 2021 on the estimation of the economic value of butterfly handicrafts in tourist zones) Market value*Bird watching touristic plans sold Market value*# of wildlife park tickets sold (Mustika et al. 2020 estimated the proportion of tourist expenditures attributable to sharks in a park based on hypothetical tourism days lost if sharks were absent from the study area) Willingness to pay for ticket entrances in scenarios with and without the species studied (Contingent valuation and choice experiments)
Socio-cultural	Market-based approaches, contingent valuation	Market value*kg wildmeat sold as opportunity cost in hunting rituals Willingness to pay for the conservation of sacred species Willingness to pay for the conservation of sacred wildlife areas
INDIRECT USE VALUE (IV)	Cost-based valuation approach, market-based approach, contingent valuation	Cost of replacing a service provided by a species (see Ishwar (2016) for vulture's decomposition services) Willingness to pay for the conservation of the ecosystem of the wildlife species (see Thompson et al. 2020 on the valuation of beaver wetlands) Estimate of carbon sequestration*CO2 Ton market value (see Berzaghi 2021 for elephant's carbon storage)
OPTION VALUE (OV)	Contingent valuation, Choice experiment	Willingness to pay for the conservation of species in a wildlife park with the idea of visiting it in the future Willingness to pay for the conservation of species within a hunting area with the idea to hunt in that area in the future Willingness to pay for the conservation of species with the idea of deriving regulating services from them in the future

NON-USE VALUE (NUV)	Contingent valuation, market-based approaches	International cooperation funds received for wildlife conservation programmes Salaries*job positions related to wildlife conservation Willingness to pay for the conservation of the species without any current or future use
DIRECT COST (DC)	Market-based approaches	Compensation of future loss of income* # deaths or injuries (in proportion to capacity lost and type of job) Market value*# livestock predated or material losses (no compensation scenario) (Market value*# livestock predated or material losses) *% non-covered by the compensation fund (compensation scenario) (Market value*# livestock predated or material losses) *% of compensation established Economic losses in public roads (e.g., cost of the public work-depreciation) *# of traffic collisions Market value*infrastructure to protect crops and livestock (e.g., fences)
INDIRECT COST (IC)	Market-based approaches	Average hour wage*# of estimated days to complete a compensation process Estimated legal costs to obtain compensation Psychological therapy cost per hour*# of therapy hours received Average hour wage*#of estimated hours spent in crop and livestock protection from predation Opportunity cost of conservation (crop income forgone, livestock income forgone, wild resource utilization foregone (Lindsay 2018))

**Appendix 2. VULNERABILITY ASSESSMENT ACCORDING TO WELL-BEING DIMENSIONS**

WELL-BEING DIMENSION	ASSOCIATED VALUE	BENEFITS	COSTS	VULNERABILITY ANALYSIS
Freedom of choice	Socio-cultural values/nutritional values	Me/my family prefer wildmeat among other proteins I have the freedom to do activities related to wildlife (e.g., hunting)	Opportunity cost: Me/my family has been forced to do things to avoid wildlife crop/livestock raiding (e.g., constant guards, school abandonment, increased wood harvesting for fences)	<p>Responses by frequency (e.g., never, sometimes, often, always)</p> <p>Responses by level of affectation (e.g., none, low, medium, high)</p> <p>Identification of risks under current and new scenarios (benefits forgone, new costs, dimensions affected)</p> <p>Disaggregation by gender/age: Who bears more of the cost? Who perceives more benefits from the value? (Women, men, men, and women equally, children) Are some costs/values only perceived by women? (See Ogra 2008)</p>
Material well-being	Material benefits (income) derived from use values	Wildmeat trade/wildlife tourism is an important source of income for my household (% of household income derived from wildlife related activities or transactions)	Direct costs: At my home income has decreased due to conflicts with wild animals Me/my relatives have skipped job due to conflicts with wild animals	
	Material values	Me/my family use wildlife parts as materials for personal use or economic activities (e.g., handicrafts, fertilizers)	Direct costs: The infrastructure of my home has suffered due to conflicts with wild animals	
Food security	Nutritional values	Wildmeat is an important source of food/protein for my household (% of household daily protein intake derived from wildmeat)	Direct costs: At my home the availability/quality of food has decreased due to crop/livestock raiding by wild animals	
Health	Medicinal values	Me/my family use wildlife or wildlife parts as medicine	Direct costs: Me/my relatives have been injured by wild animals Me/my relatives have been sick due to the overwork required to compensate loses caused by wild animals (e.g., repairing fences, replanting crops, extra work to compensate economic loses)	
Social well-being	Socio-cultural values	In my community: We share cultural beliefs related to wild animals It is a taboo/prohibition to hunt/eat certain animals We hunt animals for rituals We share wildmeat with relatives and friends Hunters go to collective hunting trips Hunters/wildlife rangers hold an elevated social status We share time with friends/relatives preparing wildmeat dishes	Indirect costs: The relationships between my family/my community have been deteriorated due to conflicts with wild animals Me/my family have not been able to receive compensation/support from the authorities in cases of conflict with wild animals  New costs under interventions (e.g., hunting prohibition): hunters stigmatization, pressure to inform on hunters in the community (Strong and Silva 2020)	



Psychological wellbeing	Psychological-wellbeing value/non-use values/recreational values	I enjoy hunting I enjoy wildlife watching I feel good knowing that wildlife exists and is conserved	Indirect costs: Me/my relatives have constant fear of wildlife Me/my family have experienced grief due to a loss of a relative or a traumatic experience caused by wild animals	
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Dimensions adapted from: (Narayan et al. 2000, Strong and Silva, 2020)