LITERATURE REVIEW
Community-based approaches to large carnivore conservation – Examples from outside Europe

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Summary

Achievement of wildlife conservation has historically relied on enforcement of legislation that prevents the killing of protected species. While this approach can be successful, continued declines in the populations of many species of conservation concern warrant the consideration of other approaches.

The conservation of large carnivores can be challenging because of their low value to local communities, caused by the financial costs they can impose through damages to livestock and by the potential for injury and death in humans. However, their conservation is an area of interest to many due to their charismatic nature, their globally declining populations and, in particular, the increasing populations of grey wolf, Eurasian lynx, brown bear and wolverine in Europe. This literature review discusses the effectiveness of involving local communities in conservation efforts and the various incentives offered to communities to gain their support for conservation activities. Its purpose is to highlight possible methods that could be applicable to conservation of large carnivores in Europe.

The literature review demonstrates that financial incentives, social incentives and management improvements can all increase tolerance of large carnivores by reducing the costs they impose on local communities, thus aiding their conservation. It also concludes that human-carnivore coexistence is best achieved by the implementation of a broad diversity of incentives and that enforcement is still a necessary part of conservation, but that it should not be relied upon as the sole mechanism with which to achieve coexistence between humans and large carnivores.

More specifically, the review shows that in order to successfully conserve large carnivores, a conservation program should:

- Monitor the populations of large carnivores and conduct research into stakeholder perceptions to better understand the major hurdles to coexistence. Appropriate, targeted conservation decisions can only be based on accurate data;
- Dispense the majority of its revenue via conservation payments to farmers/landowners that achieve successful large carnivore reproductions on their land and/or sightings of carnivores;
- Provide local people with additional sources of revenue from industries that directly use the presence of large carnivores, such as sustainable hunting, ecotourism and sustainable harvesting for parts;
- Pay a portion of revenue as compensation for depredation events with payments linked to best-practice husbandry standards, so livestock owners using poor standards/methods of husbandry would receive smaller/no payments;
- Create social incentives to conserve carnivores such as by adopting large carnivores as national emblems and in other key locations in order to increase awareness of the species and to foster a sense of association with the species. This awareness-raising can then be supported by educational programmes;
- Design and implement improved livestock management practices that decrease depredation rates.

The Conservation of large carnivores

There is a growing acceptance, in the international community, of the need to conserve biodiversity. The reasons for such a conservation movement vary from the aesthetic and ethical attractions of the presence of wildlife, to bioprospecting (i.e. the process of discovery and commercialization of new products based on biological resources), to considerations of the ecosystem services provided by nature (such as air and water purification by plants). Whatever the reasons behind this biodiversity conservation movement, there is growing pressure on governments to protect wildlife at national levels. This pressure is important, as studies show that biodiversity continues to decline (Miquelle *et al.* 2005).

Nominally, the desire to conserve biodiversity extends to all species, with particular focus on those at greater risk of extinction. However, the ease with which conservation efforts can be conducted varies between species. This, in part, is due to differences in local acceptance of species. For example, some conservation efforts for species whose presence is accepted and uncontroversial can be relatively easy to implement, while those for species whose presence is not accepted by the local community can be much more difficult to implement and much more likely to suffer conflicts between conservationists and local stakeholders.

Large carnivores inspire both fear and awe in humans, and are a highly controversial species to conserve, especially in populated rural areas. This is because the perceived value of their existence depends on the scale at which they are considered: i.e. large carnivores are viewed as having high value at international scales but low (or negative) value at local scales. At international scales, there is broad support for the conservation of large carnivores because they are highly charismatic species that inspire a great deal of attention from the general public and are often considered flagship species for conservation programs. As such, they are considered to be a high conservation priority as their continued existence is generally considered to be a good thing (whether for aesthetic, ethical or ecological reasons). Many international conservation initiatives therefore exist to protect them.

At a local scale, large carnivores are often considered to have negative values or impacts. This is because they can impose costs on communities that coexist with them by depredating livestock (Linnell *et al*. 1999), injuring and killing people or generally restricting local communities' use of land and the activities they can conduct due to the fear there presence causes. As a result, large carnivores are often killed in retaliation for loss of livestock, to prevent future loss, or more generally out of fear. Lack of acceptance of large carnivores, by local communities, can negatively affect the conservation status of these species as it can result in persecution (Mari and Sami, 2014). Lack of acceptance can also create conflicts between local people and conservationists that seek to preserve the populations of these species. It must be realised that, if conservation efforts are to be successful in the long term, achieving social acceptance of large carnivores should be no less important a conservation objective than achieving a favourable population status (Mari and Sami, 2014).

The discrepancy between the perceived values of large carnivores at local and international scales is a serious stumbling block to the success of large carnivore conservation programs. This topic is worthy of discussion as the decline of European large carnivores that, had been occurring for centuries, has recently been halted and in some areas even reversed. Thus, at least one species of grey wolf (*Canis lupus*), brown bear (*Ursus arctos*), Eurasian lynx (*Lynx lynx*) or wolverine (*Gulo gulo*) is now found in 21 EU member states (IUCN, 2015). This reversal has prompted a new discussion on what the best methods are with which to conserve these species in order to further their conservation.

This literature review considers the effectiveness of policies that aim to conserve large carnivores by preventing their use and strictly enforcing anti-poaching legislation. It then discusses other, community-based approaches to achieving human-carnivore coexistence which aim to work with local stakeholders. In doing so, this review considers the various incentives and methods offered to local communities in non-EU countries to achieve human-carnivore coexistence and evaluates their effectiveness. It also discusses how to apply these incentives to European situations and highlights some of the factors necessary for successful grassroots, community-level initiatives.

Strict protection approaches to wildlife conservation and management

At an international scale, there is general acceptance of the need to conserve large carnivore populations; however, no consensus exists regarding how such conservation is best achieved. Historically, and in many cases today, wildlife conservation has been enacted through the adoption of legislation that attempts to protect wildlife by preventing its use ('strict protection'), and the subsequent enforcement of, for example, anti-poaching legislation through policing. This enforcement of anti-poaching legislation has been shown to be the single biggest factor affecting the success of protected areas (Geldman *et al*. 2013); however, evidence suggests that it is not halting the global decline in biodiversity (Butchart *et al*. 2010), nor promoting the coexistence of human populations with it. The overuse of wildlife by humans can be linked to organised crime and profit-seeking, but also to situations where unsustainable use may be the difference between life and death for poor communities (respectively known as 'acts of greed' and 'acts of need').

The use of wildlife is considered by many, including the International Union for Conservation of Nature (IUCN), as an important conservation tool. It is imperative that such use is therefore conducted sustainably. Sustainable use is defined as "the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations" (Convention on Biological Diversity, 1992). While the unsustainable overuse of wildlife is not beneficial for conservation, sustainable use via consumptive industries such as hunting, logging or harvesting plants or animal parts (such as ivory or rhinoceros horn) can provide social and economic benefits that provide incentives for people to conserve wildlife. The ethical considerations of whether or not these industries should be supported are beyond the scope of this literature review.

While motivations behind acts of greed and those of need are radically different, their impact on the natural environment is largely similar as both can result in the decline of populations. The illegal wildlife trade is estimated to be worth USD7.8-10 billion per year (GFI, 2011). It is an international market which is often supplied by organised criminal bodies equipped with military hardware. As such, it is very difficult to combat, especially in less developed countries which often have large reserves of wildlife, potentially less stable political systems, can be more open to corruption and likely consider the conservation of wildlife as a lower priority. Furthermore, not only is the illegal wildlife trade highly lucrative but it is becoming increasingly so. As an example, the market price of ivory in China is reported to have risen from $1,300/kg in 2008 to $2,100/kg in 2014 (Save The Elephants, 2014). This trade has a significant impact on wildlife populations: from 1970 to 2001, 46-58% of the deaths of Amur tigers (*Panthera tigris altaica*) in Russia's far east were from poaching for parts for the illegal wildlife trade (Miquelle *et al*. 2005). Overuse of wildlife by humans also occurs due to a lack of alternative sources of income or food, and persecution of certain species can occur due to damage caused by these species to livelihoods and due to the loss of human life.

Whether undertaken as an act of greed or one of need, the overuse of wildlife by human communities is intense. During the 1980s the population of cheetah (*Acinonyx jubatus*) in Namibia declined from 6,000 to less than 3,000 as a result of farmers shooting animals to prevent damage to livestock (Morsbach, 1987) and from 1991-1999, 79.4% of all deaths in a second Namibian study of cheetah were caused by humans (Marker *et al*. 2002). In the Russian Far East, humans caused 80% of all deaths in Amur tigers from 1971-2001 (Miquelle *et al*. 2005) and, from 2001-2010, three leopards (*Panthera pardus*) were killed every week in India (Raza *et al*. 2012). Finally, 1,215 rhinoceros (Family: *Rhinocerotidae*) were illegally killed in South Africa in the year 2014 (Save The Rhino, 2015), an increase from the 13 that were illegally killed in 2007, despite the numbers of arrests for poaching increasing from 165 in 2010 to 386 in 2014 (Save the Rhino, 2015).

This extensive persecution of large carnivores and other species continues despite the fact that the majority of these species are strictly protected under national or international legislation. It, therefore, must be considered that strict protection-oriented approaches and their enforcement, designed to protect populations of wildlife and ensure human-wildlife coexistence by denying humans access to, and use of, animal populations, have been unsuccessful in protecting these species. This may be because these measures do not address the fundamental problem that large carnivore presence is considered negative: they don't give the

species value at local levels, but rather make them a cost to be endured, thus they either continue to be seen and persecuted as a pest, or illegally used for financial gain.

Not only have approaches that prevent the use of wildlife not worked, but in some cases poorly targeted enforcement activities have undermined local confidence in conservation authorities and the perceived legitimacy of the legal system, leading to further disincentives to conserve wildlife. In some extreme examples, enforcement approaches have resulted in drastic abuses of power resulting in incidences of destruction of property, killing, rape and torture by those tasked with enforcing the rules (All Africa, 2014). While such examples are extremely rare, they nonetheless highlight the problems involved in empowering potentially corrupt organisations to enforce legislation. Enforcement of strict protection-orientated legislation has also resulted in the deaths of both poachers and rangers (increasingly so as conservation zones and poaching groups become more militarised), by attempting to prevent population decline of species solely by military force. Strict protection-oriented legislation is also very expensive financially due to the high costs of hiring, training and equipping teams of rangers.

Furthermore, conservation measures based on strict protection-orientated legislation risk alienating local residents and losing their support by denying access to natural resources that the community relies on (nutritionally or financially), or has a cultural attachment to, as well as undermining the actions of local conservation initiatives. Conservation efforts that lack local legitimacy can also result in an increase in illegal killings: Pohja-Mykrä (2016) used the case study of Finnish resistance to internationally-imposed grey wolf conservation to show how large carnivore conservation efforts that are not supported by the local communities can result in active resistance against such efforts, manifested in illegal killings, and the support for such acts in the eyes of the local community. Conservation efforts focussing on the enforcement of strict-protection orientated legislation can therefore result in an increase in illegal killings, rather than a decrease.

As the enforcement of strict protection-orientated legislation has not halted the worldwide decline in wildlife, other methods of achieving this must be considered. The remainder of this literature review discusses other approaches and techniques towards the conservation of large carnivores. It must, however, be noted that some level of enforcement is likely to be a necessary part of all conservation initiatives.

Community involvement in wildlife conservation and management

There are alternatives to strict protection-orientated legislative approaches to wildlife conservation. A growing number of management plans are attempting to achieve the conservation of wildlife through 'grassroots' measures: by involving the local community in conservation efforts. This is reflected in the London Declaration on Illegal Wildlife Trade (2014) which notes that:

> *"We recognise the importance of engaging communities living with wildlife as active partners in conservation, by reducing human-wildlife conflict and supporting community efforts to advance their rights and capacity to manage and benefit from wildlife and their habitats" (§12).*

The involvement of local community members in conservation enterprises is preferential to their alienation as their proximity to the conservation site makes them the group most able to act on and enforce conservation principles. Furthermore, evidence suggests that conservation initiatives that involve the local community have a far greater success rate than those that do not (as will be discussed below). However, the involvement of the local community in the conservation of their resident wildlife requires incentives, low levels of conflict between humans and wildlife, trust between the community and conservation organisations and acceptance of conservation goals. This can be difficult to achieve when the species being conserved are large carnivores but is, nonetheless, possible. By-and-large, the incentives used by conservation initiatives to win community support for large carnivore conservation fall into one of three categories: financial incentives, social incentives and management improvements.

Incentive based approaches

In order to achieve coexistence between local communities and large carnivores many conservation schemes use financial incentives, such as reimbursement schemes, revenue-sharing initiatives and conservation payments, and social incentives. The effectiveness of each of these in achieving human-wildlife coexistence is examined here.

Reimbursement schemes

In many cases, antagonism between local communities and large carnivores is based on the damage they do to livestock (Marker *et al*. 2002; Maclennan *et al*. 2009). Loss of valuable livestock can result in retaliatory killing of carnivores believed to have been responsible (which can result in misidentification of animals and the killing of 'innocent' individuals) and pre-emptive killing of carnivores to prevent future losses. Many conservation initiatives therefore attempt to promote human-carnivore coexistence by providing compensation payments when an animal has been depredated, usually at the market value of the animal in question. An alternative but similar scheme is to provide an insurance system whereby livestock owners pay for membership of the insurance program that then pays out after a depredation event. These reimbursement schemes usually involve the farmer reporting the loss of livestock, which is then verified by the organisation. Payment is only made once it has been confirmed the animal was a victim of large carnivore predation. Such schemes aim to reduce the occurrence of retaliatory killings and thus conserve the carnivore population.

Reimbursement schemes have seen some success, for example: reduced animosity of livestock owners towards large carnivores (due to reduced costs of coexistence) has been seen in Yellowstone National Park, USA since the introduction of a compensation scheme (Nyhyus *et al*. 2003), whereby the organisation 'Defenders of Wildlife' compensates ranchers for wolf depredation (Defenders of Wildlife, 2015); in India, a communal compensation scheme protecting snow leopards (*Panthera uncia*) has successfully resulted in an increase in the population (Mishra *et al*. 2003), while another Indian scheme involving compensation has successfully achieved coexistence between Asiatic lions (*Panthera leo persica*) and humans (Banerjee *et al*. 2013) during which time the lion population has grown (Singh and Gibson, 2011); in Kenya the 'Maasai Predator Compensation Fund' achieved a 87-91% reduction in the number of lions killed (Hazzah *et al*. 2014) by paying owners for depredated livestock, while the 'Mbirikani Predator Compensation Fund' also achieved a reduction in the number of lions killed (Maclennan *et al*. 2009) using the same method; and, in the Russian far east, the 'Siberian Tiger Project' compensated owners of livestock lost to Amur tiger depredation, ensuring that no tigers were killed in retaliation for depredation events from 1993-2001 when the project ended (Miquelle *et al*. 2005).

However, reimbursement schemes are not flawless: uptake of insurance payment schemes can be low if the approach is novel or if depredation rates are generally too low to justify expense on insurance (Miquelle *et al*. 2005); payments for verified depredation events do not cover ancillary costs of living alongside carnivores such as direct and opportunity costs of guarding livestock (Thirgood *et al*. 2005; Macdonald *et al*. 2010), for example: in Himalayan India, payments for livestock loss amounted to 10-30% of an animal's market value and took two years to come through (Jackson and Wangchuk, 2001).

It is important to note that compensation may not actually reduce human-carnivore conflict, for example: in Wisconsin, USA, reimbursement of a depredated animal's value did not increase tolerance of wolves (Naughton-Treves *et al*. 2003), but could incentivize a reduction in livestock protection, increasing losses and exacerbating conflict (Bulte and Rondeau, 2005). Lowered costs of depredation could also incentivise the keeping of larger, more ecologically damaging herds of livestock (Bulte and Rondeau, 2005); and finally, reimbursement schemes usually require large sources of external funding, the permanence of which is often an issue. Such a requirement means compensation schemes are always at a risk of bankruptcy (Bulte and Rondeau, 2005).

Despite their potential, reimbursement schemes often fail to achieve human-carnivore coexistence alone, or cannot do so in the long term. As a result, they struggle to single-handedly achieve carnivore conservation, but

are often successfully used alongside other methods as they usually do increase tolerance of carnivore presence.

Revenue-sharing initiatives

Human-carnivore coexistence is best achieved when local communities feel that the presence of carnivore species is a benefit to their life in some way. Considering the fact that ecotourism and big game hunting industries (two sectors where large carnivores are important components) are highly profitable, one method of achieving coexistence is to pass a percentage of the incomes earned by industries that sustainably use large carnivores to the local communities that suffer costs associated with their presence. This gives communities a financial incentive to conserve them.

Evidence shows that revenue-sharing can increase wildlife populations, for example: from 1977-1994 in Kenya 19-65% of wildlife was lost in an area where the majority of the revenue from ecotourism was kept by the tourism industry; no wildlife was lost where revenues were shared; and wildlife increased by 12% where private landowners kept all of the revenue (Norton-Griffiths, 1998), because landowners had an incentive to conserve the wildlife. Also in Kenya, revenue-sharing has been used to successfully foster human-carnivore coexistence and generate growth of wildlife populations: where revenue-sharing occurs, opinions on wildlife are significantly more positive (Groom and Harris, 2008), thus carnivores are less likely to be killed by local inhabitants. In Tanzania's Tarangire National Park $16,520 was spent on school buildings and equipment from 1992-1997; this revenue-sharing is suggested to have resulted in decreased poaching rates and has unequivocally been shown to have resulted in increased occurrence of villagers informing park staff of poaching incidents and the presence of poachers in the village, revealing the improved tolerance of conservation activity. As a result, from 1995 until the end of the study (1997), no poaching events occurred within the park (Kangwana and Mako, 1998). Finally, in Namibia, where local stakeholders keep all revenue from local wildlife use, lion populations are increasing (Namibian Association of Community Based Natural Resource Management, 2008).

In Rwanda the presence of gorillas (*Gorilla gorilla berengei*) generated $294 million worth of ecotourism in 2013 (of which 5% is invested in the community). This money both builds support for conservation measures in local communities and actively reduces poaching rates by employing ex-poachers as 'Gorilla guardians' acting as both guards and outreach workers; as a result of this investment, occurrences of snares and other forms of poaching have decreased 50% in some areas (Roe, 2015). In comparison, Dian Fossey spearheaded a campaign to enforce legislation that prevented people from any access to, or use of, habitats used by gorillas as a method of conserving their population. This fostered no trust between local communities and the conservation initiative, resulted in executions of gorillas in retaliation, and is even suggested to have led to Fossey's death (Gordon, 1994).

Another revenue-sharing initiative is seen in Tanzania: there, the Ruvuma Elephant Project recruits game scouts from the local population to work alongside government rangers and receive performance-based rewards. The Project also educates communities and suggests methods to reduce human-elephant (*Loxodonta africana*) conflicts such as the use of chilli fencing to deter elephants while also producing a cash crop. Local villagers also report poaching activities and this has led to a dramatic reduction in poaching (PAMS Foundation). Use of gorillas and elephants as examples in a discussion of large carnivores is applicable as they can pose a threat to humans health (Sabaterpi, 1966; National Geographic, 2005) and cause economic losses, through crop raiding (Berggorilla, 2015; Big Life), in the same way as large carnivores.

A case of particular relevance to European large carnivores is that of American crocodiles (*Crocodylus acutus*) and ASOCAIMAN (Association for the Conservation of the Caimans of the Bay of Cispata) in Columbia. Here, a group of ex-hunters are working towards conservation of American crocodiles (ASOCAIMAN, 2015); this work has resulted in the stabilisation of the population and is beginning to reverse their decline (Ulloa and Sierra, 2002). The organisation is currently operating for no economic gain, but is hoping for the population to

recover to a point where the species is downlisted to CITES appendix II to allow limited trade in animal skins (the population is currently afforded appendix I classification).

A second example where legalised harvesting of individuals is in the interest of the species' conservation is seen in rhinoceroses (Family *Rhinocerotidae*) in South Africa: a report by Martin (2011) highlights the fact that methods to conserve rhinoceroses, through enforcement of strict protection legislation, have been tested over the past 30 years and have failed, as evidenced by the continued and increasing incidences of poaching (Emslie, 2013). Some US$400 million is spent annually to protect the rhino population from poaching for the illegal rhino horn market, while the capital value of all the horn on the present rhinoceros population is estimated at US$780 million and a single animal produces horn worth just under US$10,000 annually. This means that the value of land supporting a rhino population managed under a dehorning program is at least 100 times greater than the value of land supporting domestic livestock (Martin, 2011). This economic situation means that conservation of rhinoceros populations would be best achieved through abandoning protection-orientated legislation and adopting a strictly-regulated program of dehorning.

It could be argued that establishment of European large carnivore populations to a point where regulated hunting and a taxable trade in animal parts was possible would allow sales and tax revenue to be reinvested in the conservation of the species and in revenue-sharing initiatives in the local community, minimising human-carnivore conflict. As legal, regulated and sustainable hunting of large carnivores already occurs in much of Europe, this point has already been reached; as a result a regulated trade in animal parts could be sustainably operated. Two animal groups this potential revenue stream most applies to are tigers (*Panthera tigris*) and bears (Family Ursidae), for whose parts large markets already exist (Tigers in Crisis, 2015). Internationally, the illegal trade in bear parts is estimated to be worth €2 billion and markets exist for bear pelts, gall bladders, paws and claws (Interpol, 2014). Sustainable harvesting of these parts for sale on legalised markets could help finance conservation measures.

Another case of interest is that of jaguars (*Panthera onca*) in southern USA. Here jaguar conservation initiatives may soon include allowing livestock farmers who agree to not take lethal measures against predators to promote themselves as 'jaguar-friendly beef', thus creating a potentially profitable selling point to consumers (Nistler, 2007). This same approach could be taken with European livestock herds such as Swedish reindeer and with European cattle and sheep farmers, by creating a 'predator-friendly meat' category. This could be allocated to livestock owners who take measures to conserve predators on their land.

Revenue-sharing schemes are not perfect however and, if badly managed, can fail to result in conservation benefits. They may not actually result in an increase in wildlife as distributional inequalities may result in the individuals who suffer the most human-carnivore conflict receiving the least benefits, as in the case of African rural/nomadic pastoralists benefiting less from community infrastructure, thus maintaining the same lack of tolerance of carnivores (Walpole and Goodwin, 2000). Many revenue-sharing initiatives are not conditional upon actually delivering conservation benefits, leading to situations where local communities are positive towards the revenue-generating tourism but not the wildlife that generates the tourism: in Nepal's Makalu-Barun National Park locals enjoy the benefits of ecotourism revenues but still call for the lethal control of snow leopards and other livestock-damaging wildlife (Mehta and Kellert, 1998).

The success of revenue-sharing initiatives can also cause immigration to the wildlife hotspot leading to land conversion and degradation of the environment (Wittemyer *et al.* 2008). Finally, revenue-sharing initiatives may foster conflicts between local communities and conservation initiatives as conservation prevents the land from being used optimally, resulting in 'enforced primitivism': households adjacent to Mantadia National Park, Madagascar were calculated to suffer annual losses of $419 (more than half the local annual wage) mainly due to restricted access to agriculture (Shyamsundar and Kramer, 1997).

The risks associated with badly managed revenue-sharing schemes restrict the extent to which such schemes are embraced by local communities, and therefore their success at fostering tolerance and coexistence

between humans and carnivores. However, as exemplified by the successes of such schemes, well-managed revenue-sharing initiatives can provide a method of solving the fundamental issue associated with large carnivore conservation: their negative local value (Kangwana and Mako, 1998; Groom and Harris, 2008). This is due to the fact that, if managed correctly, wildlife can be given great financial value through commodification (however see Russell & Ankenman, 1996, and Gómez-Baggethun & Ruiz-Perez, 2011 for some risks of commodification of wildlife). The fact that local inhabitants receive a tangible benefit from their presence can help foster human-carnivore coexistence, therefore the sustainable use of such wildlife populations can help ensure the long-term survival of the species. Such uses can include sustainable hunting, photo-tourism and potentially harvesting for parts.

While revenue-sharing initiatives are not the solution to issues of human-carnivore coexistence alone, they have been shown to succeed, and are a key element in the conservation of large carnivores that can also be used alongside reimbursement schemes and other methods.

Conservation payments

Another method of fostering good relationships between local communities and large carnivores through financial incentives is to make payments for conservation results rather than conservation actions. Conservation payments are made on the basis of the community achieving a desired environmental outcome, not on factors assumed to result in that outcome; i.e. payments are made when evidence for human-carnivore coexistence exists, not for factors assumed to result in coexistence (Nelson, 2009). Conservation payments have been generally successful in wildlife conservation, for example: The Nature Conservancy pays US landowners an annuity in return for the rights to log the forest in ways that maximise terrestrial and aquatic biodiversity (Gilges, 2000). They have also been used to conserve large carnivores: Mexican landowners are paid if a camera trap records an endangered felid species on their farm (Nistler, 2007) and the 'Defenders of Wildlife' organisation rewarded US landowners for occupied wolf dens on their property (Defenders of Wildlife, 2015). Such a conservation payment system already exists in Europe, in Sweden: the Swedish government pays Sami reindeer herders $29,000 for each certified successful lynx or wolverine reproduction on their land to pay for reindeer depredation (Dickman *et al*. 2011). This, along with other measures, has successfully resulted in increasing wolf population size in Sweden (Zabel and Holm-Mueller, 2008) although their range/abundance is mainly restricted to non-Sami reindeer areas.

Conservation payments are superior to other financial incentives as they are more successful at fostering human-carnivore coexistence. This is because they have low transaction costs as livestock owners do not have to search for depredated livestock, increasing the efficiency of the process of payment for landowners. Conservation payments also reduce the cost of maintaining traditional lifestyles in areas of human-carnivore coexistence; this builds further support for the conservation initiative.

As with the other financial incentives however, conservation payments are not perfect. Payments made to individual farmers require clearly defined land rights (something that may not exist), while payments made to communities to be shared amongst the members require functional systems of collective action. Payments may also be manipulated by local elites leading to a marginalisation of the poorest in the community. Furthermore where insecure land rights exist these payments may increase the attractiveness of the land, leading to land grabs.

In conclusion, conservation payments are, and will continue to be, important tools in the establishment of large carnivore-human coexistence and carnivore conservation. This is particularly true when used alongside other forms of financial incentives as discussed above.

Financial incentives summary

In summary, successful payment initiatives set out to:

1. Specifically target payments to those most directly affected by carnivores;
2. Reduce the direct costs of human-carnivore coexistence;

3. Provide local people with additional revenue directly linked to carnivores (such as via hunting, ecotourism or harvesting for parts);
4. Avoid perverse incentives such as incentivising increased depredation by paying for each livestock unit lost;
5. Not require significant external revenue;
6. Specifically link payments to conservation outcomes;
7. Be likely to have a positive impact on human poverty.

None of the three approaches described above cover all of these individually, therefore the most successful initiatives will combine approaches. Revenue should be primarily dispensed as conservation payments for recorded presence/reproduction of a large carnivore. A large portion should be invested in community-driven development initiatives that provide a tangible benefit of the presence of large carnivores (such as financial benefits achieved through regulated hunting, ecotourism or harvesting for parts) to local inhabitants, while another portion should be paid as compensation for depredation events (payment would be linked to husbandry standards, so livestock owners using poor standards of husbandry would receive smaller payments). Determining which initiatives would most benefit a particular community should be highly site-specific, and would require dialogue with the community. Organising financial incentives in this way would help achieve human-carnivore coexistence and the conservation of large carnivores.

These approaches all require extensive external investment, either from external industry such as hunting or tourism, or from donations; attempts to achieve self-sufficiency such as through insurance schemes have often failed due to low uptake (Miquelle *et al*. 2005). Markets such as the European hunting sector (conservatively estimated to be worth €16 billion (Kenward and Sharp, 2008)) present an extremely viable industry to financially support conservation efforts of large carnivores through regulated, sustainable hunting. However, in order to guarantee long-term sustainability of large carnivores, conservation incentives must be provided that are not based on financial inputs in order to supplement those that are.

Social incentives

For the continued success of large carnivore conservation, incentives other than financial ones must be found. One approach attempted by several conservation initiatives is to create or exploit social elements to achieve human-carnivore coexistence through awareness-raising and by fostering a sense of association with the species. This awareness-raising can then be supported by educational programmes.

Firstly, one method of achieving greater human-carnivore coexistence is to simply recognise a problem exists. The persecution of Ethiopian wolves (*Canis simensis*) in the early 1990s by local communities was reduced by recognising that local concerns over the land's management were legitimate (Gottelli and Sillero-Zubiri, 1992). In a second example, North American communities angry at elitist environmentalists vented their frustration at grizzly bears (*Ursus arctos* ssp.); this situation improved when a complaints forum was established (Primm, 1996).

Recognition of a problem and the implementation of appropriate actions to overcome it are likely to require research into both the human and animal populations present in a given situation. This research helps to assess stakeholder perceptions, determine the hurdles to human-carnivore coexistence and collect data on the large carnivore in question in order to both monitor the population and determine the validity of any complaints from local stakeholders. The efficacy of collecting data on stakeholder perceptions as a method of achieving conservation of wildlife was highlighted by the Mali Elephant Project, whereby simply talking to local communities and discussing their problems it was possible to garner local support for elephant conservation projects (Canney, 2014).

Secondly, many communities have cultural attachments to the wildlife they coexist with. This may be for religious, aesthetic or ethical reasons. These attachments can be exploited to achieve conservation aims. In the Maasai people of Kenya, lion hunting is a cultural tradition that serves to demonstrate the prowess of a warrior and continues despite legislation banning the activity. This tradition was threatened by falling lion

population levels (partially as a result of intense hunting). The Kenyan 'Lion Guardians' project managed to incorporate the traditional hunting of lions into a conservation program whereby men 'hunt' the lions in order to tag them with radio telemetry collars, allowing them to be tracked for research purposes (Lion Guardians, 2015). Such guardians are paid a modest wage and gain prestige and status by still being seen as a lion 'hunter'. The Lion Guardian program has been extremely successful and has resulted in a 99% decrease in lion killings (Hazzah, 2014). This is a key example of where traditional, unsustainable, use of a carnivore population has been turned on its head to support conservation efforts. Conservation of wildlife purely for aesthetic reasons and for a sense of community pride have also been shown in Manyeleti Game Reserve, South Africa, where 83% of the interviewed community thought removal of the predator population was not an option despite 81% having lost livestock to carnivore depredation. Of those that viewed predator removal as unacceptable 9% did so for reasons of tourism and job creation but the overwhelming majority did so for aesthetic and ethical reasons (Lagendiik and Gusset, 2008).

Social incentives such as these could be used in the case of European large carnivores. Establishing a sense of national or regional pride around a particular carnivore species through awareness-raising and educational activities could help associate a group of people's sense of identity with a species of conservation concern, and could help garner support for the conservation of that species and reduce rates of retaliatory or pre-emptive killing among those in conflict with it. Actions similar to this have been seen in the reintroduction of lynx into the Harz National Park, Germany where the lynx was used as a flagship conservation project and an attraction for the park. Fostering a sense of cultural ownership and solidarity with a large carnivore species could be achieved by incorporating one in a logo, or adopting one as a mascot, and then publicising this by any organisations or bodies from sports teams and cities, to political parties and businesses.

Efforts to foster a sense of association between communities and large carnivores, in this manner, could also be supported by educational activities that aim to improve the knowledge communities possess about the large carnivores living in their vicinity (Kellert *et al*. 1996; Infield and Adams, 1999). Such actions could help to improve local opinion of large carnivores by causing them to relate positively with the species in question. By broadening people's understanding of the environment, their concern for species existing in it can be heightened, leading them to support conservation actions in the long-term (Dietz and Nagagata, 1995). An example of these methods can be seen in the 'Ethiopian Wolf Conservation Program' which, since 1996 has been operating a community education approach to reduce the persecution of wolves by shepherds (Sillero-Zubiri and Macdonald, 1997). A local teacher is employed to work with local people and talk to them about dogs, disease and wildlife using educational materials in the local Oromo language, as well as to lecture at local primary schools about wolf conservation and other environmental issues. It is currently too early to determine the long-term success of these educational activities.

While such measures have the potential to achieve considerable results in human-carnivore coexistence they can take time to foster the sense of identity with the species in question and take effect. Furthermore, few concrete examples of the success of social incentives exist. As such, it is important that these measures are used to supplement other conservation initiatives, and are not relied upon alone.

Management improvements

Human-carnivore coexistence relies upon carnivores not being perceived to have a negative value at a local scale. One simple way to achieve this is to reduce the costs a carnivore can impose on a community by improving management practices. This can be done with minimal investment of revenue.

Damage by carnivores to livestock incurs considerable financial costs for the livestock owner. In Himalayan India, education of the herder population and construction of more predator-proof livestock pens has reduced the number of livestock lost to leopard attacks and is suggested to have reduced the number of retaliatory killings (Jackson and Wangchuk, 2001). In northern Turkey, increased tolerance of bear presence has been achieved by introducing new methods of storing apiaries (on raised metal poles rather than suspended from a cliff face) which still prevent bear access while increasing human access, reducing conflicts between the human and carnivore populations (Can *et al*. 2014).

In 1995, the management of the Russian Far East's wildlife population was handed to hunting organisations in order to give them a vested interest in the sustainable maintenance of these populations, bringing the human population further into conflict with tigers as these depredated the ungulate population. In 2000 the Wildlife Conservation Society initiated a program to improve management of huntable species in these areas through support and education, which reduced human-tiger conflict by providing a larger prey population for both human and carnivore populations, and in experimental leases this has resulted in increased ungulate population size (Miquelle *et al*. 2005). In Namibia, conservation organisations introduced improved livestock management through the use of calving corrals, guarding animals and synchronising calving seasons between farms. This led to a reduction in the rate of depredation by cheetah greater than that achieved by their lethal removal (Marker *et al*. 1996).

These approaches show that with minimal financial investment, but with investment of the time of skilled personnel, and using basic educational activities, human-carnivore coexistence can quickly and easily be made to impose a lower cost on local communities, thus resulting in lower rates of retaliatory killing. This reduced cost of coexistence is also likely to increase tolerance for the species and reduce the rate of pre-emptive killing. These approaches are applicable in Europe as growing populations of wolves, bear, lynx and wolverines are increasingly bringing the species into contact with livestock. With the adoption of new, simple farming practices (e.g. the adoption of electric fencing), human-carnivore coexistence can be made far easier with minimal investment of funds.

Simple changes to management practices such as these cannot achieve perfect human-carnivore coexistence, nor can they reduce conflicts if management practices that result in high human-carnivore conflicts are deeply culturally ingrained. However, they can greatly increase tolerance of large carnivore presence, and can be included as part of a financial and cultural incentive program.

Conclusion

In conclusion, the conservation of wildlife is increasingly dependent upon the tolerance of human-wildlife coexistence by humans. The conservation of large carnivore populations is particularly difficult due to the financial costs imposed on local communities via damage to livestock, and due to the threat of injury and death to people. This results in large carnivores being perceived as having low value at local levels, while generally being viewed as having high value at international scales for ecological, ethical and aesthetic reasons. The preservation of large carnivore populations is therefore controversial and can be difficult to achieve.

This literature review has considered the different approaches to achieving coexistence of local communities with large carnivores. It has shown that despite some successes, conservation of large carnivores through top-down enforcement of strict protection legislation alone is often unsuccessful as it does not address the fundamental negative or low value of these species to the local communities that coexist with them.

An alternative method of preserving wildlife is to work with local communities and stakeholders to provide incentives for them to coexist with large carnivores. This literature review has considered financial incentives such as reimbursement schemes, revenue-sharing initiatives and conservation payments, and has shown how together these practices can be used to great effect to increase tolerance of large carnivore populations.

Furthermore, while these schemes require financial support, initiatives such as these could be made to be financially self-sustaining (or at least more so) by the legalisation of regulated, sustainable hunting or harvesting of animal parts for sale. Hunting in Europe is widespread and worth an estimated €16 billion to the European economy; financing of conservation measures by tapping into this market, such as through the regulated sale of hunting trips, would help projects achieve greater self-sustainability. Sustainable culling of European bears and harvesting of their parts for a legal market could provide a considerable source of funding for conservation measures; whether such a trade should be supported is beyond the scope of this review.

Social incentives could also be used alongside financial incentives if sufficient support for a species could be built. These benefit from having minimal costs but are more difficult to achieve and few examples exist; however, if an emotional connection could be fostered between local communities and the species, social incentives could be very useful in achieving human-carnivore coexistence.

Management improvements can also be implemented with minimal financial backing and hence could be introduced even in the absence of external financial support. These reduce the costs of large carnivore presence, increasing the ease of coexistence.

Individually financial incentives, social incentives and management improvements can all have successes, but, if managed badly, may have some potential negative consequences as well. It is important to be aware of these and manage conservation efforts in ways that avoid these if at all possible. An overview of the pros and cons of the various different methods can be found in appendix 1.

However, financial incentives, social incentives and management improvements will be most successful if used together to complement each other. Enforcement of strict-protection orientated conservation approaches is also likely to be necessary to successfully conserve large carnivores, but the message of this literature review is to not rely solely on strict protection. A focus on strict-protection orientated approaches is unlikely to achieve social acceptance of large carnivore presence or conservation initiatives targeting them, which may ultimately provide an unsurmountable stumbling block to conservation efforts. A diverse range of conservation practices is likely to best achieve coexistence of humans with large carnivores in Europe and elsewhere.

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Appendix 1

Strict Protection-Orientated Approaches

Pros	Cons
Enforcement of strict protection-orientated legislation has been shown to be the single biggest factor affecting the success of protected areas.	The continued decline of global biodiversity is proof that strict protection-orientated approaches are not working. Strict protection-orientated approaches have not promoted the coexistence of human populations with those of large carnivores. Strict protection-orientated approaches can alienate local people, reducing support for conservation efforts and, if such efforts are seen as illegitimate, can result in an increase in illegal killings. Poorly targeted enforcement activities have undermined local confidence in conservation authorities and the perceived legitimacy of the legal system, leading to further disincentives to conserve wildlife. Enforcement of strict protection-orientated legislation is very expensive financially and results in loss of human life as poachers can be armed with military-grade equipment.

Incentives based approaches

Reimbursement schemes

Pros	Cons
Reimbursements are targeted to those directly coexisting with large carnivores.	Reimbursements often either do not cover the full market value of the animal or do not cover ancillary costs of coexisting with large carnivores.
Insurance schemes could be financially self-sufficient.	Payments can take a long time to be made.
	Payments can incentivise a reduction in livestock protection or the keeping of larger, ecologically damaging herds.
	Uptake of insurance schemes can be very low if the approach is novel or if depredation rates are generally low.
	Reimbursement schemes require external funding to operate.

Revenue-sharing initiatives

Pros	Cons
Provides local communities with a tangible benefit to coexisting with large carnivores, giving them a value. This has been shown to increase tolerance for large carnivore populations and decrease tolerance for illegal poaching activities.	Distributional inequalities may result in the individuals who suffer the most from the presence of carnivores receiving the least benefits.
If revenue-sharing proceeds are invested in improving education, this can feed back into increased support for future conservation activities.	Revenue-sharing payments may not be conditional upon delivering conservation benefits, leading to a situation whereby opinions on the revenue-generating industry are favourable but not the wildlife that generates the industry.
Extensive, lucrative markets with which to operate revenue-sharing activities already exist in the form of hunting, ecotourism and possibly harvesting species (e.g. bears) for parts for sale on legalised markets.	Success of revenue-sharing initiatives can cause immigration towards the wildlife hotspot, leading to increased environmental degradation.
Successful examples of revenue-sharing initiatives already exist in many locations.	Industries funding revenue-sharing initiatives may prevent the land from being developed, resulting in 'enforced primitivism' and causing conflicts between local communities and conservationists.

Conservation Payments

Pros	Cons
Payments are made for actual conservation results, therefore ensuring the success of the project.	Payments to individual land owners require clearly defined land rights, while payments to communities require functional systems of collective action.
Successful examples of conservation payments exist in many locations, including Europe.	Payments may be manipulated by local elites leading to marginalisation of the poorest in the communities.
Low transaction costs exist as livestock owners do not have to search for depredated livestock.	Where insecure land rights exist payments may increase the attractiveness of the land, leading to land grabs.
Reduce the cost of maintaining traditional lifestyles in areas of human-carnivore coexistence.	Conservation Payments require external funding to operate.

Social Incentives

Pros	Cons
Cheap and more easy to implement than other approaches.	Few concrete examples of the success of social initiatives exist.
Can exploit a pre-existing attachment to local wildlife and build upon it to achieve conservation aims.	Can take a long time for social actions to take effect and result in positive conservation actions.
Educational activities to garner support for conservation actions can have long-term positive consequences resulting from a more educated human population.	Social initiatives cannot be relied upon alone, so must be heavily supported by other incentives.

Management Improvements

Pros	Cons
Improving management practices, and therefore reduction of human-carnivore conflicts, can be done with minimal financial investment.	Management improvements can be very difficult to implement if practices that result in high human-carnivore conflicts are deeply ingrained in the local culture.
Have been shown to successfully improve local communities' tolerance of large carnivores by reducing human-carnivore conflicts.	