

Managing Conflict: Coexistence with Bears, Cougars, and Wolves

A literature reference



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Introduction

Wolves, grizzly bears, and cougars are symbolic and contested animals. They are vital to ecosystem health, but represent wilderness and mystery to some and vermin and destruction to others. Whether large carnivore populations expand numerically or spatially is not a question just for the natural sciences. The issue is ultimately grounded in human values and perspectives about the natural world and our proper relationship to it. Large carnivore restoration and persistence is directly tied to our willingness and commitment to living with and alongside them.

Promoting or practicing coexistence and human-wildlife conflict prevention requires navigating a complex and, at times, contentious management landscape. To assist practitioners, advocates, and managers in this complex work, we compiled and summarized peer-reviewed science across a variety of disciplines relative to large carnivore conservation and conflict management. The collection is broad but conflict-focused.

Below are descriptions of the categories included in the compilation. We have not included papers on backcountry encounters, bear spray, or direct conflicts with people.

Collaborative and Community-Based Practice and Management: This category reflects experiences and best practices for engaging local citizens and communities or using collaborative strategies.

Compensation Programs: These papers are about different kinds of livestock loss compensation programs or other schemes to prevent conflicts or conserve carnivore habitat.

Habitat Conditions, Movement, and Connectivity: This grouping reflects information about the habitat attributes that can cause or predict conflict, or conditions needed for connectivity or dispersal.

Hunting: This category relates to how hunting may relate to or possibly cause conditions leading to large carnivore conflicts. This does not include studies about the use of hunting as a tool for predator control.

Patterns of Conflict: This section includes studies about the causes of conflict or the risk of conflict, as well as conflict over time and across multiple scales.

Policy, Governance and Social Science: This is an umbrella category under which are two sub-groupings: Policy & Governance, and Social Science. The former is self-explanatory; the latter relates to values and attitudinal research, and papers asserting the relevance of social science to management decisions.

Lethal Control: This includes papers about the effectiveness of lethal control strategies and its impacts.

Nonlethal and Preventative Tools: This grouping reflects studies of the efficiency and effectiveness of various nonlethal conflict prevention or mitigation tools and practices.

The compilation index begins on the next page. In many cases papers are in more than one category. Citations are abbreviated in the index but are provided in full with the abstract summaries (beginning on page 21). We recognize that there are many informative materials in circulation relating to this topic; here, we abstracted peer-reviewed journal articles only.

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a. Policy & Governance

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Literature

Agarwala M, Kumar S, Treves A, Naughton-Treves L. 2010. Paying for Wolves in Solapur, India, and Wisconsin, USA: Comparing Compensation Rules and Practices to Understand the Goals and Politics of Wolf Conservation. *Biological Conservation* 143:2945-55. DOI:10.1016/j.biocon.2010.05.003.

With growing pressure for conservation to pay its way, the merits of compensation for wildlife damage must be understood in diverse socioecological settings. Agarwala et al. compared compensation programs in Wisconsin, USA, and Solapur, India, where wolves survive in landscapes dominated by agriculture and pasture.

At both sites, rural citizens were especially negative toward wolves, even though other wild species caused more damage. Wisconsin and Solapur differ in payment rules and funding sources, which reflect distinct conservation and social goals.

In Wisconsin, as wolves recolonized the state, some periodically preyed on livestock and hunting dogs. Ranchers and some hunters were more likely to oppose wolves than were other citizens. The Wisconsin compensation program aimed to restore an iconic species by using voluntary contributions from wolf advocates to pay affected individuals more for wolf losses than for other species. By contrast, wolves had been continuously present in Solapur, and damages were distributed among the general populace. Government-supported compensation payments were on offer to anyone suffering losses, yet claims registered were low. There were no significant differences in attitudes of any particular segment of the population, but those losing high value livestock applied for compensation. Residents at both sites did not report (Wisconsin) or expect (Solapur) a change in attitude toward wolves as a result of compensation, yet they support the existence of such programs.

To assess the merits of any compensation program, the authors suggest that those involved need to disentangle the multiple goals of compensation, such as reducing wolf killing or more fairly sharing the costs of conserving large carnivores.

Andelt WF. 2004. Use of Livestock Guarding Animals to Reduce Predation on Livestock. *Sheep and Goat Research Journal* 19:72-75.

Livestock guarding dogs have been reported to effectively deter coyotes, mountain lions, and black and grizzly bears from livestock (although there is conflicting testimony as to their effectiveness with wolves). Time saved in herd management is reportedly often greater than time required to feed and work guarding dogs, and guarding dogs generally reduce reliance on lethal predator control techniques. Dogs are adaptable to many rangeland conditions and are effective across a range of pasture sizes and types. Donkeys and llamas have also been successfully deployed to reduce predator conflicts with livestock. They are typically used to protect sheep from coyotes.

Andelt studied the use of guarding animals and found that each animal type can confer some disadvantages. Some dog breeds can be aggressive toward people, and they are always susceptible to injury and premature death—disadvantages that are relatively uncommon, but can impose a cost on a livestock producer. Andelt found that donkeys and llamas can be introduced into herds of sheep at low

cost with little or no added upkeep expense; however, they often react very aggressively toward canids, and are, by and large, a much less effective deterrent than dogs—and considered ineffectual in confrontations with wolves or bears.

Andelt argues that guarding animals are effective tools for mitigating livestock depredation, and that guarding dogs are a particularly cost-effective way of reducing predation in many situations.

Apps CD, McLellan BN, Proctor MF, Stenhouse GB, Servheen C. 2016. Predicting Spatial Variation in Grizzly Bear Abundance to Inform Conservation. *Journal of Wildlife Management* 80(3):396-413. DOI:10.1002/jwmg.1037.

Grizzly bear management and conservation is a highly publicized and politically charged issue, especially near the southern fringe of the species' range where human presence, activities, and development are prevalent and often increasing. Understanding of spatial structure of populations is fundamental to effective assessment, planning, and management for species conservation.

Apps et al. evaluated landscape composition relative to grizzly bear detection based on independent surveys conducted in the area (southeastern British Columbia and southwestern Alberta) between 1996 and 2010. Their underlying goal was to provide a foundation for regional management, conservation planning, and recovery efforts, whereby specific population estimates can be derived for any area, and population core, and peripheral and linkage landscapes can be inferred and assigned conservation priorities and strategies.

Apps et al. argue that spatial predictions for any defined population are likely to be more reliable than those extrapolated from tracking data of individual animals given limitations typical of such sampling. And that, ultimately, model output provides regional population context for environmental assessment, management, and conservation planning, nested within what should be finer-scale data and prediction where available.

Baruch-Mordo S, Breck SW, Wilson KR, Broderick J. 2009. A Tool Box Half Full: How Social Science Can Help Solve Human-Wildlife Conflict. *Human Dimensions of Wildlife* 14(3):219-23. DOI:10.1080/10871200902839324.

There is a growing recognition among wildlife managers that focusing human-wildlife conflict management on just wildlife often provides a temporary fix, whereas changing human behavior can provide long-term solutions.

Baruch-Mordo et al. provide some insight into the importance of integrating human dimensions into conflict management, and some of the work done to date through direct observation of human behavior and self-reported behavior—two methods currently employed to measure the success of management actions in changing human behaviors.

The authors point out their own interest in improving our ability to manage wildlife by broadening understand of human dimensions work. They call on social scientists to help in this effort by

implementing applied experiments that evaluate the efficacy of management actions aimed at changing human behavior. Additionally, they encourage researchers from both disciplines to develop collaborative efforts in order to better respond to current and future coexistence needs.

Bennett NJ, Roth R, Klain SC, Chan K, Christie P, Clark DA, Cullman G, Curran D, Durbin TJ, Epstein G, Greenberg A, Nelson MP, Sandlos J, Stedman R, Teel RL, Thomas R, Verissimo I, Wyborn C. 2016. Conservation Social Science: Understanding and Integrating Human Dimensions to Improve Conservation. *Biological Conservation* 205:93-108. DOI:10.1016/j.biocon.2016.10.0006.

Historically, the natural sciences have tended to be the sole or primary information source used to guide conservation action. Yet, many influential conservation scientists have long recognized the importance of both social and natural considerations for conservation. Social science research on conservation is increasingly commonplace as are commentaries on the need for more attention to the human dimensions of conservation. However, the integration of social science insights into conservation practice still remains limited and the field of conservation social science remains nascent.

Bennett et al. examine the scope and purpose of 18 subfields of classic, interdisciplinary, and applied conservation social sciences and articulate 10 distinct contributions that social sciences can make to understanding and improving conservation. They contend that the social sciences can help facilitate conservation policies, actions, and outcomes that are more legitimate, salient, robust, and effective.

Benz RA, Boyce MS, Thurfjell H, Paton DG, Musiani M, Dormann CF, Ciuti S. 2016. Dispersal Ecology Informs Design of Large-Scale Wildlife Corridors. *PLoS ONE* 11(9). DOI:10.1371/journal.pone.0162989.

Conservation efforts for large mammals by wildlife managers and conservationists typically focus on identifying and maintaining wildlife corridors to facilitate movement through human modified landscapes (Laurance et al. 2008). Recent methods for designing corridors involve radio-telemetry data to determine the least-cost path for best placement. However, this connectivity modeling method typically uses species location or habitat preference rather than movement, which may not capture dispersal limitations or opportunities.

Implementing dispersal ecology into landscape connectivity, Benz et al. observed patterns of habitat selection by dispersers during different phases of colonization to infer habitat connectivity. They believe that the combination of advanced connectivity modeling tools with behavior and ecology of target species could aid conservation managers in making better-informed management decisions.

Bergstrom BJ. 2017. Carnivore Conservation: Shifting the Paradigm from Control to Coexistence. *Journal of Mammalogy* 98(1):1-6. DOI:10.1093/jmammal/gyw185.

A consensus is emerging among ecologists that extirpated, depleted, and destabilized populations of large predators are negatively affecting the biodiversity and resilience of ecosystems. Evidence

assembled as of 2011 has led prominent ecologists to conclude that loss of apex predators was a major driver of destabilization and collapse of their native ecosystems (Estes et al 2011).

In this lead article of a thematic series on predator control, Bergstrom provides an overview of apex predators, wildlife management, and efficacy of lethal and nonlethal control methods. Bergstrom suggests that nonlethal methods of preventing depredation of livestock by large carnivores may be more effective; more defensible on ecological, legal, and wildlife-policy grounds; and more tolerated by society than lethal methods. Additionally, he argues that total mortality rates for a large carnivore may be driven higher than previously assumed by human causes that are often underestimated.

Bergstrom BJ, Arias LC, Davidson AD, Ferguson AW, Randa LA, Sheffield SR. 2013. License to Kill: Reforming Federal Wildlife Control to Restore Biodiversity and Ecosystem Function. *Conservation Letters* 7(2):131-42. DOI:10.1111/conl.12045.

Since 2000, the U.S. Department of Agriculture's Wildlife Services (WS) has killed 2 million native animals (WS 2012a), predominantly 20 species of carnivores, beavers, and several species of ground-dwelling squirrels, but also some non-target species. Many are important species in their native ecosystems (e.g. ecosystem engineers such as prairie dogs and beavers, and apex predators such as gray wolves).

Reducing these populations, locally or globally, risks cascading negative consequences including impoverishment of biodiversity, loss of resilience to biotic invasions, destabilization of populations at lower trophic levels, and loss of many ecosystem services that benefit human society directly or indirectly.

Lethal predator control is not effective at reducing depredation in the long term. Instead, Bergstrom et al. recommend that WS and its government partners involved in wildlife conflict management emphasize training livestock producers in methods of nonlethal control, with sparing use of lethal control by methods that are species-specific, and cease all lethal control in federal wilderness areas and for the purpose of enhancing populations of common game species.

Berkes F. 2004. Rethinking Community-Based Conservation. *Conservation Biology* 18(3):621–30. DOI:10.1111/j.1523-1739.2004.00077.x.

Conservation issues are complex systems-level problems; challenging because they cannot be disentangled from individual values, equity, and social justice—all of which are necessarily subjective. As such, many conservation problems do not actually lend themselves to the conventional, rational approach of data collection, analysis, and results-based decision making. There is too much uncertainty; targets keep shifting, and most issues must often be redefined. In that context, the most effective approaches will not be ordered along classic disciplinary lines. Rather, the issues will be addressed simultaneously at multiple scales so as to reflect the fact that they are part of a complex social-ecological system.

Berkes offers a primer on the complexities entailed by community-based conservation. He discusses interdisciplinary conservation, adaptive co-management, local and traditional knowledge, incentivization, multiple stakeholders, scale and complexity, governance, and the relationship between community and institutions. He highlights the importance of addressing situation-specific complexities when undertaking any conservation activity, and suggests that a cross-scale approach to conservation alerts us to the notion that the scale at which we view a complex system affects what we see (i.e., what problems we orient toward). A cross-scale approach also helps address governance and community issues at multiple scales, depending on the conservation problem in question.

Berkes suggests that we shouldn't necessarily be asking *whether* community-based conservation works. Sometimes it does and sometimes it doesn't. It is more important to consider the conditions under which it does and does not work. He argues that it may ultimately be more productive to focus on institutions (defined broadly as the set of rules-in-use that structure human interaction), than on communities. Practically speaking, the challenge is often to strengthen institutions that may sustain conservation, while proactively negotiating around institutions that are ordered around other values.

Blackwell BF, DeVault TL, Fernandez-Juricic E, Gese EM, Gilbert-Norton L, Breck SW. 2016. No Single Solution: Application of Behavioural Principles in Mitigating Human-Wildlife Conflict. *Animal Behaviour* 120:245-54. DOI: 10.1016/j.anbehav.2016.07.013.

Human needs for space, shelter, and food will continue to ensure some degree of perceived 'trespass' when it comes to wildlife, a situation that paves the way for human-wildlife conflicts or HWC (Conover 2002). Nonlethal management approaches are critical to mitigating HWC (Shivik 2006), and more sustainable from ecological and social perspectives (Treves and Naughton-Treves 2005, Woodroffe et al 2005). Understanding the behavior of the target species is central to the efficiency and efficacy of nonlethal methods, although the role of behavior is sometimes not explicitly acknowledged in management policies or practices.

Blackwell et al. examined the theoretical and applied role that behavior plays in understanding and mitigating HWC, particularly as it related to larger and longer-term conservation efforts, and delineated gaps in behavioral theory relative to mitigating current HWC.

Focusing on animal-vehicle collisions and carnivore depredation of livestock, they found that only in the last decade have researchers applied antipredator theoretical framework with sensory ecology to understand aspects of responses to vehicle approach, speed, and associated stimuli. Within the context of carnivore-livestock depredation, managers need to better understand individual predator behavior relative to perceived risks in order to improve efficacy of the most promising nonlethal management approaches. In both cases, successful management is contingent upon a mechanistic understanding of how animals respond to disturbance and the information utilized to assess risk.

Boast L, Houser AM, Horgan J, Reeves H, Phale P, Klein R. 2016. Prey Preferences of Free-Ranging Cheetahs on Farmland: Scan Analysis Versus Farmer Perceptions. *African Journal of Ecology* 54:424-33. DOI: 10.1111/aje.12296.

The intensity of human-predator conflicts (HPC) is linked closely to farmers' attitudes and perceptions of predators. As a result, farmers' estimates of the number of livestock or game-stock animals killed by predators are often formed based on the perceived number of predators present and their perceivably favored prey species.

Boast et al. examined the prey preferences of cheetahs in relation to farmers' perceptions and the relative contribution of livestock and game-stock to the cheetahs' diet. Overall the authors found that cheetahs on Botswana's farmland predominantly prey upon free-ranging wildlife species, despite an often greater abundance of livestock. Maintaining a diverse prey base is considered to be essential to reduce losses of predators (Marker-Kraus et al. 1996), and the number and associated costs of livestock losses are often greater in areas depleted of natural prey (Hemson 2003, Woodroffe et al. 2005).

However, on community lands in Botswana and across southern Africa, natural prey is thought to be declining due to land conversion to agriculture, habitat degradation and poaching (Mordi 1989, Moleele and Mainah 2003). Management options to promote veld management, and to diversify and improve rural livelihoods in order to discourage poaching could aid the recovery of natural prey populations, which is likely to reduce HPC. In addition, farmers' perceptions of the prey species consumed by cheetahs were often incorrect; the authors suggest that conflict mitigation programs which emphasize and promote the importance of free-ranging prey in the cheetah's diet are likely to increase tolerance of predators.

Boitani L, Ciucci P, Raganella-Pelliccioni E. 2010. Ex-Post Compensation Payments for Wolf Predation on Livestock in Italy: A Tool for Conservation? *Wildlife Research* 37:722-30. DOI:10.1071/WR10029.

Compensation programs have become a common tool for mitigating conflicts between humans and predators over depredations. The theoretical and social justification for compensation programs is obvious, because they respond to the need for equity in sharing the costs of large-predator conservation in human-inhabited areas. As such, they are expected to alleviate the burden of losses for farmers/ranchers and to reduce animosity toward predators and illegal killing.

Theoretically, compensation for livestock losses to predators is part of a broader spectrum of incentives for environmental services. Operationally, incentives for prevention measures and proper husbandry practices need to play a role. This is true of ex-post as well as ex-ante compensation.

Boitani et al. discuss implementation and effectiveness of compensation programs, focusing on the case of wolf-damage in Italy. They contend that the effectiveness of compensation programs is based on a series of assumptions that should be carefully and continuously assessed within an adaptive management framework. Compensation programs have obvious limits if they are considered the only (or primary) tool available to manage carnivore-livestock conflicts. Boitani et al. argue that they should be well supported by an effective and trusted system. Practical husbandry improvements may also go a long way to preventing conflicts, and the authors recommend that compensation policies be designed to stimulate adherence to minimal standards of practice.

Boitani et al. conclude that wolf-damage compensation programs in Italy currently provide no evidence of being a functional and cost-effective conservation tool. They are characterized by a lack of effective monitoring and accountability at all institutional levels. In light of persistently high occurrence of wolf-livestock conflict, widespread illegal killing of wolves, increasing wolf numbers, and marked changes in livestock husbandry practices, the authors contend that current compensation programs are an unwise and unsustainable strategy to reduce the conflict.

Bradley EH, Pletscher DH, Bangs EE, Kunkel KE, Smith DW, Mack CM, Meier TJ, Fontaine JA, Niemeyer CC, Jimenez MD. 2005. Evaluating Wolf Translocation as a Nonlethal Method to Reduce Livestock Conflicts in the Northwestern United States. *Conservation Biology* 19(5):1498-1508.

Translocation has been used for decades as a tool to mitigate livestock damage caused by bears, wild felids, and wolves. It helped further the Northern Rockies wolf recovery during its early phases by establishing new packs, as well as by augmenting existing packs in other areas, while removing depredating wolves from problematic locations.

Nonetheless, many translocated wolves die or disappear soon after release, without ever establishing a territory. Some others cause additional conflicts, resulting in their eventual lethal removal. Although most translocated wolves do not kill livestock after release, problems still often persist at the original conflict sites. As a result, translocated wolves that do prey on livestock in their new area contribute to higher net numbers of conflicts.

Bradley et al. examined the effectiveness of wolf translocation and found that translocation was most useful in the northern Rockies during early phases of wolf recovery, when encouraging establishment of new packs was a high priority and when there were ample suitable release sites.

Translocation has benefits and drawbacks. Now that wolf populations are larger, many of the benefits of translocation are reduced. Nonlethal efforts may be better focused on preventing and mitigating depredations at the original site of conflict, rather than simply moving or removing problem individuals. It is worth reiterating that conflict sites often persist beyond the removal of individual wolves, unless root causes are addressed. Preemptive conflict-mitigation efforts may prove useful to reduce conflicts as well as to help build a foundation for promoting coexistence within communities over the long term.

Bradley EH, Robinson HS, Bangs EE, Kunkel K, Jimenez MD, Gude JA, Grimm T. 2015. Effects of Wolf Removal on Livestock Depredation Recurrence and Wolf Recovery in Montana, Idaho, and Wyoming. *Journal of Wildlife Management* 79(8): 1337-1346. DOI: 10.1002/jwmg.948.

Management methods used in Montana, Idaho, and Wyoming to mitigate wolf predation on livestock are highly controversial and heavily scrutinized, and their effectiveness is poorly understood. Wolf conflicts are managed primarily through lethal removal by agencies and public harvest to manage wolf numbers and distribution (USFWS et al. 2014); methods considered both necessary (Mech 1995) and controversial (Cluff and Murray 1995, Reiter et al. 1999, Bruskotter et al. 2009). Little was known, however, about the effects of removing depredating wolves on their packs' subsequent behavior.

Focusing on radio-collared packs in these three states, Bradley et al. examined data on livestock depredations and wolf removal conducted under authority of the USFWS and state agencies from 1989 to 2008. They examined the relative effects of three management responses—no removal, partial pack removal, and full pack removal—considering grazing seasons, livestock types, pack size, and removal of breeding individuals. They also analyzed depredation occurrence relative to increases in wolf population, and impact on wolf recovery overall.

Whereas previous large, regional-scale studies (Musiana et al. 2005, Harper et al. 2008, Wielgus and Peebles 2014) found no effect, or even a positive correlation between wolf removal and subsequent depredations, Bradley et al. found that scale matters. Their ability to examine individual packs and pack territories revealed that wolf removal did appear to reduce recurrence of depredations at the local level depending on the number of wolves remaining in the pack, and that depredation management is most appropriately studied at the wolf pack-level or local scale.

Brainerd SM, Andren H, Bangs EE, Bradley EH, Fontaine JA, Hall W, Iliopoulos Y, Jimenez MD, Jozwiak EA, Liberg O, Mack CM, Meier TJ, Niemeyer CC, Pedersen HC, Sand H, Schultz RN, Smith DW, Wabakken P, Wydeven AP. 2008. The Effects of Breeder Loss on Wolves. *Journal of Wildlife Management* 72(1)89-98. DOI:10.2193/2006-305.

Since wolves are highly social pack animals and each animal has a role in their community, the death of an individual can have varying significance depending on their status in the pack. Wolf managers periodically rely on the removal of depredating wolves, so it is important for managers to understand the effects of breeder loss on wolf social groups, relative to broader goals and strategies.

Brainerd et al. studied pack behavior in cases where one or both breeding members (alphas) were lost, tracking three key properties: pup survival, pack persistence, and the time to next breeding for persistent packs. The sex of a single surviving breeder was of little significance in determining whether a wolf pup in its pack would survive its first year. It was also relatively unimportant whether one or both breeders survived. Of more consequence was the total number of surviving adult wolves (whether breeders or auxiliary), because adults share responsibility for rearing the pups after weaning. They found that smaller packs showed a greater tendency to dissolve after breeder loss; dissolved packs disbanded into solitary adults who either joined neighboring packs or attempted to form their own; territorial wolves reestablished packs and recolonized the area in about half of the cases where observed packs dissolved; and neighboring packs occasionally expanded or shifted their territory to usurp the abandoned area.

The authors recommend that steps be taken to minimize the impact of breeder loss, which has a significant impact on the ability of a pack to persist and reproduce. Selective removal of pack members is difficult; thus, the authors argue that lethal control should be limited to solitary individuals or territorial pairs wherever possible. When reproductive packs must be managed, it is recommended that only those with pups greater than six months of age and greater than six pack members with at least three adult members be selected. This will maximize the odds that the pack persists. The authors also recommend that these packs should be close to neighboring packs and occur within larger (≥ 75) recolonizing populations.

Breck SW, Clark P, Howery L, Johnson D, Kluever BM, Smallidge S, Cibils AF. 2012. A Perspective on Livestock-Wolf Interactions on Western Rangelands. *Rangelands* 34(5):6-11. DOI:10.2111/RANGELANDS-D-11-00069.

Seeking to provide a science-based perspective to inform the ongoing wolf-livestock debate, Breck et al. conducted field and pen studies in Arizona to determine how predator (wolf and cougar) and non-predator presence or stimuli affect vigilance rates and foraging of cattle and wild ungulates. The authors also conducted two studies on allotments in Idaho and eastern Oregon to evaluate effects of wolf presence on cattle habitat selection, terrain use, activity budgets, expression of predation-avoidance behavior, and productivity.

Results from the Arizona studies suggest several management implications to reduce the indirect effects of predation on cattle foraging behavior and to address animal distribution challenges. These include increased range riding and monitoring of mother cows during the calving season; synchronization of calving season to occur in locations with no or low wolf density; c) communication with wildlife biologists collared wolves' locations; and encouraging cattle forage in larger groups or in the same areas as wild ungulates.

The Northern Rockies studies suggest a need for more research due to the complexity of the ecological system and numerous interacting factors. The authors suggest producers consider carnivore presence when developing grazing plans and, overall, the need for a better understanding of wolf impacts on livestock in open grazing systems.

The authors suggest more intensive management of livestock combined with lethal and non-lethal wolf management strategies—multiple tools and techniques used in a context-dependent fashion and integrated into a science based operation supported by producers

Breck SW, Kluever BM, Panasci M, Oakleaf J, Johnson T, Howery L, Bergman DL. 2011. Domestic Calf Mortality and Producer Detection Rates in the Mexican Wolf Recovery Area: Implications for Livestock Management and Carnivore Compensation Schemes. *Biological Conservation* 144:930-36. DOI:10.1016/j.biocon.2010.12.014.

Minimizing depredations and increasing tolerance by livestock producers is critical for conservation efforts. Breck et al. investigated factors influencing calf mortality and producer detection rates at two sites in the Mexican wolf recovery area. Study areas differed in grazing practices, density of predators, and amount of effort spent monitoring cattle.

Calves selected by predators were on average 25 days younger than the surviving cohort. Year-round calving is practiced in these study areas. Results indicate that year-round calving, especially in areas with high predator densities, leads to higher losses primarily because vulnerable calves are exposed to mortality agents for a higher proportion of time.

Breck et al. suggest these results support changing husbandry practices to limit calving to a seasonal endeavor. In a broader sense, it highlights the importance of monitoring livestock and targeting the timing and location of calving/lambing so as to minimize exposure to predators.

Widely disparate mortality detection rates across these study sites highlight the significance of producer effort in finding and verifying depredations. Breck et al. suggest that compensation programs—utilized to mitigate the economic effects of carnivores—should focus on performance-payment schemes where payment is based on conservation outcomes (e.g., carnivore offspring) and compensation is based on damage that animals are expected to cause (rather than inconsistent and difficult to verify ex-post claims).

Browne-Nunez C, Treves A, MacFarland D, Voyles Z, Turnig C. 2015. Tolerance of Wolves in Wisconsin: A Mixed Methods Examination of Policy Effects on Attitudes and Behavioral Inclinations. *Biological Conservation* 189:59-71. DOI:10.1016/j.biocon.2014.12.016.

Understanding attitudes toward wolves and wolf management is important because they can predict how people may behave toward wolves and respond to wolf management actions (Bruskotter et al. 2009). Monitoring change in attitudes over time is of particular relevance in wolf management given the high level of polarization and continuously evolving management landscape. For instance, numerous studies have shown that majorities of survey respondents held positive views of wolves, but a 2001-2009 panel study found declining tolerance for wolves among residents of Wisconsin's wolf range.

Browne-Nunez et al. conducted focus groups and anonymous questionnaire surveys among hunters and farmers in Wisconsin's wolf range to gain a more in-depth understanding of attitudes toward wolves and inclination to poach wolves. The authors convened focus groups before and after Wisconsin implemented lethal-depredation control and created the state's first legalized wolf-harvest season in 2012.

Their results showed majorities of respondents held negative attitudes toward wolves with no decrease in inclination to poach, suggesting lethal-control measures, in the short term, may be ineffective for increasing tolerance. Participants expressed favorable attitudes toward lethal-control measures, but believed there were limitations in their implementation. Focus group discussions revealed elements of positivity toward wolves not revealed by questionnaires, as well as several thematic areas—fear, empowerment, trust—that may inform in the development of interventions designed to increase tolerance of wolves and other controversial species.

Participants did express appreciation for being asked for input; feelings of powerlessness were in part the result of perceived dominance of outside groups in affecting state/local policy. The authors support the use of a mixed-methods approach when exploring sensitive human-wildlife topics, and encourage participatory research methods in order to empower individuals and groups. These may offer managers the opportunity to not only increase perceived and actual stakeholder empowerment, but also increase trust by increasing avenues of communication between agencies and constituents.

Bruskotter JT, Enzler SA, Treves A. 2011. Rescuing Wolves from Politics: Wildlife as a Public Trust Resource. *Science* 333(6051):1828-29. DOI:10.1126/science.1207803.

In the absence of Endangered Species Act protection, wolf management reverts to the states. Will states honor the substantial public investment made in wolf restoration or seek to dramatically reduce or even

eliminate wolf populations? The answer may depend on how states interpret a legal doctrine with roots dating back to ancient Roman and English common law.

Bruskotter et al. explore the history and intent of the public and wildlife trust doctrines, state wildlife powers, and the need to develop case law necessary for broader judicial application of the wildlife trust. The authors argue that without judicial application of an enforceable obligation, the fate of wolves, and many other imperiled species, remains uncertain.

Bruskotter JT, Fulton DC. 2012. Will Hunters Steward Wolves? A Comment on Treves and Martin. *Society and Natural Resources* 25(97-102). DOI:10.1080/08941920.2011.622735.

As wolf conservation transitions away from federally sponsored protection and recovery toward sustainable management under state fish and game agencies, researchers, and policymakers are interested to know what role hunters will play. Based upon hunters' responses to three recent surveys in Wisconsin and the northern Rockies, Treves and Martin (2011) question the assumption that hunters will steward wolves, noting that the majority of hunters that responded were unsupportive of wolf conservation. However, this conclusion largely depends upon what is meant by stewardship and what actions are required for wolves to be conserved.

Bruskotter and Fulton explored three concepts explicitly or implicitly discussed by Treves and Martin—tolerance, acceptance, and stewardship—and offer a conceptual model of wildlife conservation behavior that they argue clarifies the relationship among these concepts.

They note that the U.S. Fish and Wildlife Service delisted wolves under the assumption that state management would build tolerance for the species (Bruskotter et al. 2010). This is but one of many untested assumptions regarding how to go about mitigating the threat posed by human beings—the only legitimate threat to wolves in the lower 48 states (Bruskotter et al. 2010, Smith et al. 2010).

Bruskotter JT, Toman E, Enzler SA, Schmidt RH. 2010. Are Gray Wolves Endangered in the Northern Rocky Mountains? A Role for Social Science in Listing Determinations. *BioScience* 60(11):941-948.

The question of how to manage wolves in the Northern Rockies transcends the biological and ecological sciences. Wolf management efforts underscore how intricately human behaviors are linked with the long-term success of the species. Of 2094 wolf mortalities documented by the US Fish & Wildlife Service between 2000 and 2009, 84% were human caused, and at least 80% of these were intentional control actions or harvest. Within that context, it has frequently been observed that wolf recovery issues have more to do with personal values than with wolves themselves.

This does not diminish the importance of biophysical-ecological data in management. It suggests, however, that the social sciences can also provide valuable information that should be considered in decisions such as listing determinations. Despite lip-service to the contrary, social sciences are not integrated sufficiently into controversial conservation actions (even those pertaining to species like wolves that have long-recognized human connections).

Bruskotter et al. suggest that management agencies have historically failed to sufficiently address social factors in their management decisions. They argue that when agency decisions turn on assumptions about society, agencies should employ appropriate social science methodologies to explicitly evaluate those assumptions in order to improve policy and management decisions.

Bruskotter J, Vaske J, Schmidt R. 2009. Social and Cognitive Determinants of Utah Residents' Acceptance of the Lethal Control of Wolves. *Human Dimensions of Wildlife* 14:1-14. DOI:10.1080/10871200802712571.

Public acceptance of wildlife-related policies and actions is critical to successful implementation of management and the conservation of a species. It has been found that lethal control of species, particularly charismatic mega-fauna such as bears, wolves, and deer, is highly controversial.

State and federal agencies must determine which methods of control are acceptable for species likely to cause controversy and identify factors that affect the acceptability of lethal control. Bruskotter et al. used a mail-in study from 709 Utah Residents to: (1) describe the acceptability of various means of controlling wolves that prey on livestock; (2) examine factors associated with the acceptability of lethal control; and (3), develop a model predicting the acceptability of lethal control.

The study showed that three factors—cognitive, social, contextual—can be related to the acceptability of wildlife management actions. Bruskotter et al. found that acceptability of lethal controls varied among the stakeholder groups, but there was no variation among stakeholder opinions regarding non-lethal methods suggesting that non-lethal methods are less controversial.

The authors note that variations linked to lethal controls were reduced when beliefs about wolf impacts and attitudes toward wolves were controlled; these two factors explained 42% of the acceptability variance. They suggest that effects of stakeholder identification on acceptability of lethal control are influenced by cognitive factors.

Carroll C, Rohlf DJ, Li Y-W, Phillips MK, Noss RF. 2014. Connectivity Conservation and Endangered Species Recovery: A Study in the Challenges of Defining Conservation-Reliant Species. *Conservation Letters* 8(2):132-38. DOI:10.1111/conl.12102.

Listing of species under the US Endangered Species Act (ESA) is designed to trigger an array of federal regulatory provisions that protect both the species and its habitat in order to allow a species' status to improve to the point at which the measures provided pursuant to the ESA are no longer necessary. Some of the earliest species delisted were threatened by things that could be comprehensively addressed by federal regulations.

In contrast, many currently listed species face ecologically complex threats that are less amenable to regulation remedy (Doremus and Pagel 2001). Many species have experienced a reduction in population connectivity (Soule and Terborgh 1999), which may impact demographic and genetic flows that support persistence of peripheral populations and long-term maintenance of a species' evolutionary potential (Lowe and Allendorf 2010).

Carroll et al. reviewed the limited guidance provided by the ESA and subsequent case law related to what level of connectivity restoration is appropriate before a species is delisted. They then considered examples from a range of listed species to discover commonalities that can clarify key questions regarding connectivity restoration for endangered species.

Carroll et al. found that for species facing long-term threats from invasive species or climate change, restoration of natural dispersal may not be technically feasible in the foreseeable future. For other species, restoration of natural dispersal is feasible, but carries economic and political cost. They argue that distinguishing between these two groups better informs policy by distinguishing the technical challenges posed by novel ecological stressors and the degree to which we should grow accustomed to direct human intervention in species' lifecycles as a component of conservation.

Carter NH, Linnell JDC. 2016. Co-Adaptation is Key to Coexisting with Large Carnivores. *Trends in Ecology and Evolution* 31(8):575-78. DOI:10.1016/j.tree.2016.05.006.

Protected areas are crucial for large carnivore conservation. However, the vast ranges required by these animals mean that co-occurrence with humans is, and has been, common in shared landscapes outside protected areas. Given that shared landscapes often represent a vital part of their remaining geographic distribution, eradication of large carnivores from these areas threatens their conservation.

Operationalizing human-carnivore coexistence in these areas is essential to global carnivore recovery efforts and maintaining (or improving) human wellbeing (Ripple et al. 2014, Chapron et al. 2014, Carter et al. 2014), but an unclear, inconsistent, or naïve conceptualization of coexistence hinders the ability of opposing stakeholders to implement coexistence strategies.

Carter and Linnell articulated a coexistence definition that focused on mutual adaptation on the part of both humans and carnivores, including human-carnivore and human-human interactions, that can help unify disparate interpretations of coexistence so that human and natural systems are fundamentally integrated.

They suggest that their concept of coexistence can be a starting point from which to advance both the interdisciplinary theory and practice of coexistence.

Carter NH, Shrestha BK, Karki JB, Pradhan NMB, Liu J. 2012. Coexistence Between Wildlife and Humans at Fine Spatial Scales. *Proc Natl Acad Sci* 109(38):15360-365. DOI:10.1073/pnas.1210490109.

The extent and degree to which threatened wildlife can coexist with humans over a sustained period is a central issue in conservation science and policy (Woodroffe et al. 2005, Dickman et al. 2011). Numerous conservation models (regional, community-based, etc.) have been proposed and implemented, but a rapidly growing global population and a long history of competition between people and wildlife for limited resources have led to a general belief among conservation practitioners and policy makers that some wildlife species, such as large carnivores and ungulates, cannot coexist with humans at a fine spatial scale (Cardillo et al. 2004, Karanth et al. 2010, Brashares et al. 2001, Parks and Harcourt 2002).

Finding a lack of empirical and quantitative data on the capacity and mechanisms for wildlife to coexist with humans in close proximity, Carter et al. investigated the spatiotemporal patterns of tigers (*Panthera tigris*) and human activities inside and outside Chitwan National Park in Nepal in 2010 and 2011.

They found that tigers and people frequently co-occurred at fine scales both inside and outside the park; that estimates of tiger density were higher than other sites in Central and North India, Laos, Indonesia, Malaysia, and Bhutan; and that human foot traffic across the study site was also orders of magnitude greater than traffic reported in other areas. Carter et al. believe that tiger density remained high even while population increased because the tigers were adjusting their activity in space and time according to the type and magnitude of human presence.

Chamberlain E, Rutherford M, Gibeau M. 2012. Human Perspectives and Conservation of Grizzly Bears in Banff National Park, Canada. *Conservation Biology* 26:420–431. DOI:10.1111/j.1523-1739.2012.01856.x.

Conservation initiatives have the potential to stir up intense conflict among stakeholders due to conflicting views on conservation problems and solutions. Tools are needed to depolarize such situations, help to foster understanding of the perspectives of people involved, and find common ground.

Chamberlain et al. studied the perspectives of stakeholders (local residents, scientists, agency personnel, and representatives from NGOs and other interest groups) on conservation and management of grizzly bears in Banff National Park and the Bow River watershed of Alberta, Canada. The authors found that individuals from different groups held different views about grizzly bears, parks, and humans in the Banff-Bow Valley as well as different definitions of the problem of grizzly bear management. Furthermore, they established clear links between the way participants defined the problem and the solutions they preferred.

The results were used to inform a series of workshops in which stakeholders developed and agreed on new management strategies that were implemented by Parks Canada. The study is important in determining motives and values in various individuals, and finding common ground between stakeholders in order to develop proactive management strategies.

Chapron G, Lopez-Bao JV. 2016. Coexistence with Large Carnivores Informed by Community Ecology. *Trends in Ecology and Evolution* 31(8):578-80. DOI:10.1016/j.tree.2016.06.003.

Biodiversity is facing a major crisis and conservation efforts are failing to reverse the sixth mass extinction caused by the increasingly destructive impact of humans on the biosphere (Ceballos et al. 2015). Many large carnivore species are at risk of extinction (Ripple et al. 2014); however, despite being densely populated, and having few areas free from human activities, Europe today hosts growing populations of bears, lynx, and wolves (Chapron et al. 2014).

Most European countries share a common approach to large carnivore conservation; they allow carnivores and humans to share the same landscape, or at least do not actively prevent them from doing so on a large scale. Chapron and Lopez-Bao call this “strong” coexistence—wherein humans adopt practices and tools that decrease the chances of negative interactions, and carnivores adapt their ecological role to decrease instances of interaction overall.

Chapron and Linnell’s framework, informed by ecological theory, suggests that coexistence between large carnivores and humans could be achieved by both reducing human competitive abilities and increasing the differentiation of their realized niche from those of other large carnivores.

Chynoweth MW, Coban E, Altin C, Sekercioglu CH. 2016. Human-Wildlife Conflict as a Barrier to Large Carnivore Management and Conservation in Turkey. *Turkish Journal of Zoology* 40:972-83. DOI:10.3906/zoo-1509-6.

In Turkey, the co-occurrence of eight medium-large carnivore species combined with a burgeoning human population and unsustainable consumption of natural resources increasingly threatens carnivore populations. To better understand human–wildlife conflict in Turkey and provide potential solutions, Chynoweth et al. conducted surveys in 2006, 2010, and 2014 in 58 distinct settlements surrounding the Sarıkamış-Allahuekber Mountains National Park in Kars, Ardahan, and Erzurum provinces.

The authors found that respondents regularly interact with large carnivores and 77.2% experience harm from wildlife, typically in the form of damage to agricultural fields and livestock. Farmers and shepherds are more likely to have a negative perspective of carnivores than students, shopkeepers, and laborers. However, human perceptions of carnivores and the desire to be involved with ecotourism are improving over time.

Chynoweth et al. suggest that human perceptions of wildlife are a barrier to conservation and management of wildlife populations. The research, education, and outreach framework they outline can be used to address human–wildlife conflict across Turkey and guide ongoing conservation efforts of Turkey’s existing, and increasingly threatened, large carnivores.

Clark DA, Slocombe DS. 2011. Adaptive Co-Management and Grizzly Bear-Human Conflicts in Two Northern Canadian Aboriginal Communities. *Human Ecology* 39:627-40. DOI:10.1007/s10745-011-9423-x.

For remote communities, horizontal and vertical institutional connections are important for facilitating learning and the integration of information in wildlife management. Clark and Slocombe examined two case-studies of human-grizzly bear conflict in northern Canada, inquiring into whether management crises can drive the emergence of adaptive co-management. In both cases, grizzly bear-human conflicts acted as focusing events that in some ways engendered comparable responses. Nonetheless, the specifics of each context entailed different functional outcomes.

In both cases, existing institutions deliberately investigated local knowledge to inform future decisions about wildlife conflicts. In one case, existing institutions coped with the conflicts more-or-less

successfully, without having to be modified (the bear-human system buffered the changes without having to change its structure). In the other case, bear-human conflicts pushed the system into reorganization and prompted community-level participants to undertake a transformation of the management/decision-making system. This case was characterized by very few vertical and no formal horizontal connections among governance institutions, giving it unwieldy rigidity when it was felt that management regimes needed to evolve.

Both cases exhibit most of the conditions that are generally agreed to be necessary for successful adaptive co-management. The most apparent explanatory difference probably lies in the policy environment for local collaborative management efforts. Though both cases have mandates for co-management, they functionally vary in terms of the richness and density of interconnection across different institutional scales.

Clark and Slocombe suggest that the emergence of adaptive co-management may require a hospitable niche in time, space, and society that is likely to be a narrow one. Cross-scale institutional communication and venues for collaborative learning seem to be critical for positive outcomes. The authors observe that cross-scale communication is necessary for institutional learning and adaptation to change.

Clark DA, Slocombe DS. 2011. Grizzly Bear Conservation in the Foothills Model Forest: Appraisal of a Collaborative Ecosystem Management Effort. *Policy Sciences* 44:1-11. DOI:0.1007/s11077-010-9118-y.

Ecosystem approaches to conservation have been promoted for large carnivores worldwide. Nonetheless, carnivore conservation depends on more than understanding the species' biological needs. Societal values, narratives, and the institutions that give them expression are now recognized as critical determinants of bear survival—not least because of strong symbolism(s) attached to grizzlies. To date, many ecosystem management efforts have not attended sufficiently to these human dimensions.

Clark and Slocombe examined the development and eventual termination of a collaborative grizzly bear conservation program in the Foothills Model Forest (FMF), in west-central Alberta. The regional ecosystem approach for conserving grizzlies in the FMF originated in the federal and provincial legislative processes, but proved vulnerable to shifting goals and containment by a single powerful participant. It operated on open consensus and shared decision-making principles, but was effectively terminated prior to the implementation of any of its findings or recommendations; an outcome perceived by some stakeholders as the result of a goal shift and containment strategy originating from one particular group of participants.

Clark and Slocombe suggest tenuous prospects for grizzlies will probably not improve without fundamental improvements in governance. The ecosystem approach implemented in the FMF was evidently vulnerable to manipulation. It was simply not sustainable despite its origins in federal and provincial legislation: administrative changes by one participant (namely the Alberta government) were sufficient to terminate it. To enable success of other such conservation efforts, Clark and Slocombe recommend supporting emergent small-scale initiatives, designing collaborative institutions that limit the potential for containment of decision processes.

Coleman TH, Schwartz CC, Gunther KA, Creel S. 2013. Grizzly Bear and Human Interaction in Yellowstone National Park: An Evaluation of Bear Management Areas. *Journal of Wildlife Management* 77(7):1311-20. DOI:10.1002/jwmg.602.

Wildlife managers often rely on permanent or temporary area closures to reduce the impact of human presence on sensitive species. In 1982, Yellowstone National Park created a program to protect threatened grizzly bears from human disturbance. The bear management area (BMA) program created areas of the park where human access was restricted. The program was designed to allow unhindered foraging opportunities for bears, decrease the risk of habituation, and provide safety for backcountry users.

Coleman et al. evaluated human-bear interaction in BMAs to determine if the restricted areas were effective. They used human and grizzly bear global positioning system location data to study 6 BMAs from 2007 to 2009, contrasting data when BMAs were unrestricted (open human access) and restricted (limited human access).

Coleman et al. found that grizzly bears were twice as likely to be within a human recreation area (HRA) when BMAs were restricted, and that grizzly bears were more than twice as likely to be within an HRA when BMAs were unrestricted but people were inactive. They suggest that human presence can displace grizzly bears if people are allowed unrestricted access to the 6 BMAs studied, and that the results provide evidence for utility of management closures designed to protect a threatened species in a well-visited park.

Costello CM, van Manen FT, Haroldson MA, Ebinger MR, Cain SL, Gunther KA, Bjornlie DD. 2014. Influence of Whitebark Pine Decline on Fall Habitat Use and Movements of Grizzly Bears in the Greater Yellowstone Ecosystem. *Ecology and Evolution* 4(10):2004-18. DOI:10.1002/ece3.1082.

When abundant, seeds of the high-elevation whitebark pine are an important fall food for grizzly bears in the Greater Yellowstone Ecosystem. Rates of bear mortality and bear/human conflicts have been inversely associated with WBP productivity. Recently, mountain pine beetles have killed many cone-producing WBP trees. Costello et al. used fall Global Positioning System locations from 89 bear years to investigate temporal changes in habitat use and movements during 2000–2011.

One-third of sampled grizzly bears had fall ranges with little or no mapped WBP habitat. Most other bears appeared to select for WBP habitats. The authors detected no trends in movement indices over time. Outside of national parks, there was no correlation between the MC indices for WBP habitat and secure habitat, and most bears selected for secure habitat. Nonetheless, mean MC index for secure habitat decreased over the study period during years of good WBP productivity.

The wide diet breadth and foraging plasticity of grizzly bears likely allowed them to adjust to declining WBP. Bears reduced use of WBP stands without increasing movement rates, suggesting they obtained alternative fall foods within their local surroundings. However, the reduction in mortality risk historically associated with use of secure, high-elevation WBP habitat may be diminishing for bears residing in multiple-use areas.

Crook SES. 2014. Information Spread in a Region of Human-Mountain Lion Coexistence. *Human Dimensions of Wildlife* 19(6):555-58. DOI:10.1080/10871209.2014.918220.

The media has a significant role in spreading information about human-wildlife conflict, but they are just one of a number of sources from which the public garners knowledge. Knowing the sources of public knowledge can provide managers and researchers insight into how attitudes, knowledge, and risk perceptions are formed, and how to prioritize and structure education and outreach to achieve management goals.

Using a convenience sampling approach focused on attitudes about mountain lions, Crook surveyed adult residents living in and around the Santa Cruz Mountains—home to an estimated 70 mountain lions—asking them about their experiences with the animals, their sources for information, and their frequency of information exposure.

The survey results demonstrated that the majority of respondents had experience with mountain lions and received information about mountain lion issues from friends and neighbors nearly as frequently as from media sources.

Few respondents reported hearing about mountain lions directly from officials or scientists, and analysis of relevant articles found in the local newspaper, cited other citizens more often than members of government agencies.

Crook suggests that government officials, scientists, and NGOs may consider prioritizing influence building through outreach campaigns in addition to increasing their presence in the media. However, he noted that given the convenience sampling approach was adopted for his study, caution should be exercised in generalizing study findings to the entire population.

Decker D, Jacobson C, Brown T. 2006. Situation-Specific “Impact Dependency” as a Determinant of Management Acceptability: Insights from Wolf and Grizzly Bear Management in Alaska. *Wildlife Society Bulletin* 34(2):426-32.

Decker et al. explored the way in which peoples’ opinion of lethal control depends on situation-specific context. They addressed whether the perceived impacts of wildlife on humans make a difference in whether individuals tend to support (or oppose) lethal management actions.

Study respondents were more likely to support lethal methods to control wolf and bear predation on trophy game animals (moose and caribou). Conversely, lethal control of predator populations was less likely to be supported in situations where the impact of predators on game populations was perceived to be less severe (with respect to human needs).

The authors describe this relationship as ‘impact dependency,’ and suggest that it is important to consider context-specific influences on public evaluations of management actions. Although they stress the importance of other characteristics of management interventions (e.g., relative humaneness, cost, efficiency, etc.), the authors suggest that managers should consider how public support for a particular action is influenced by public perceptions—particularly relating to the nature of how the situation is impacting people.

Dickman AJ. 2010. Complexities of Conflict: The Importance of Considering Social Factors for Effectively Resolving Human-Wildlife Conflict. *Animal Conservation* 13:458-66. DOI:10.1111/j.1469-1795.2010.00368.x.

How people perceive and react to risks is heavily influenced by social-cultural perceptions and values, particularly in regard to ideas of what the world *should* be like. For example, orientation to whether wild carnivores *should* be part of a natural landscape affects perceptions of reasonable risk. Issues of social and economic stability/security may also heighten sensitivities to perceived risks. The landowner at the mercy of weather, commodity markets, and regulations imposed by outsiders, may be particularly sensitive to the introduction of another uncontrolled variable like wolves. Such a variable—which the landowner *can* exert some direct control over or kill—can be an easy target for the expression of feelings about even broader issues.

Conflict mitigation efforts often fail because conservation biologists make broad assumptions about human attitudes and behavior that do not match the realities of the situation. Dickman points out that human-wildlife conflicts are often shaped and driven by complex social factors. Moreover, he argues, they often invoke underlying human-human conflicts (i.e., between authorities/government and local people, or between people of different cultural backgrounds).

Dickman tabulates a number of conflict mitigation approaches and recommends that conservation biologists examine their local situations in-depth and carefully consider what factors are influencing conflict, before deciding which mitigation strategies are likely to be most successful. Reducing wildlife damage alone will often fail to produce long-term conflict resolution. It is vital for conflict professionals to consider the assumptions they are working under, and test their veracity in the site concerned. Dickman notes that it is important to be aware of when, where, and how different conflict mitigation strategies may (or may not) produce real conservation benefits.

Dickman AJ, Macdonald EA, Macdonald DW. 2011. A Review of Financial Instruments to Pay for Predator Conservation and Encourage Human-Carnivore Coexistence. *Proc Natl Acad Sci* 108(34):13937-944. DOI:10.1073/pnas.1012972108.

Conservationists are challenged to facilitate protection of species that may be highly valued at a large (even global) scale, but have little or even negative value at a local scale. Costs and benefits involved in predator conservation often include diverse dimensions, which are hard to quantify and nearly impossible to reconcile with one another. Although human-carnivore conflict involves significant non-economic values, providing financial incentives to those affected negatively by carnivore presence is a common strategy for encouraging coexistence.

Some compensation schemes take an ex-post approach, compensating costs as they are imposed by carnivores (i.e., depredation compensation programs). Other ex-ante programs provide payments based on the assumption that carnivores will impose some general level of cost. Dickman et al. review such financial instruments, and assess the pitfalls and potentials of these methods, particularly compensation and insurance, revenue sharing, and conservation payments.

The authors argue that determining the correct level of payments is critically important: payments must be sufficient to outweigh costs imposed to the payee, but also in proportion to the actual direct

ecological benefits derived and the benefits produced for the larger stakeholder community. It is important to assess whether the threats to the carnivore population in question are actually likely to be mitigated by the program, and whether the program can be implemented at a scale likely to secure the target population.

Citing the privately funded Defenders of Wildlife compensation program in the Northern U.S. Rockies, and the Swedish government payments to Sami herders to conserve lynx and wolverine, the authors argue that conservation payments can be a beneficial tool. Any scheme needs to be tailored carefully to the individual situation to avoid problems of perverse incentives, additionality, and leakage; to ensure that the desired conservation outcomes are achieved; and to satisfy the economic and cultural needs of people bearing the costs associated with living with wildlife.

Dietsch AM, Teel TL, Manfredo MJ. 2016. Social Values and Biodiversity Conservation in a Dynamic World. *Conservation Biology* 30(6):1212-21. DOI:10.1111/cobi.12742.

People seeking to address contemporary conservation challenges by fostering pro-conservation behaviors have increasingly turned to research investigating the basis of human thought and action (Mascia et al. 2003, Schultz 2011, Bennett and Roth 2015). Understanding what shapes values, which ultimately shape human behavior, can help improve the effectiveness of conservation solutions that depend on public support.

Dietsch et al. investigated the influence of societal-level changes, such as modernization, on values in a multilevel framework, and then explored how values influence conservation support at different levels (e.g., individual and county). They found positive associations between county-level examples of modernization and mutualism, and negative associations between modernization and domination, independent of a respondent's socio-demographics.

Their findings are consistent with previous research describing how modernization as a broad social phenomenon influences values (Inglehart and Welzel 2005, Schwartz 2006), and how value shift has affected the way humans think about and interact with their surroundings, including wildlife (Manfredo et al. 2009).

Dilkina B, Houtman R, Gomes CP, Montgomery CA, McKelvey KS, Kendall K, Graves TA, Bernstein R, Schwartz MK. 2016. Trade-offs and Efficiencies in Optimal Budget-Constrained Multispecies Corridor Networks. *Conservation Biology* 00(0):1-11. DOI:10.0000/cobi.12814.

Under the pressures of rapid human development and climate change, wildlife habitat has been diminished and fragmented, which at times compromises the ability of many species to persist (Hanski and Ovaskainen 2000, Fahrig 2003, Haddad et al. 2015). Faced with these trends, conservation biologists have pushed for creation of systems of protected areas (Hole et al. 2009), which has resulted in extensive research and development of methods that inform reserve design (Sarkar et al. 2006, Moilanen et al. 2009).

Biologists and Ecologists recognize that a simple system of protected areas, serving as isolated safe havens for biodiversity, will not be sufficient for long-term biodiversity maintenance. Thus, preserving and restoring habitat connectivity is a key conservation priority for government agencies and conservation organizations (Crooks and Sanjayan 2006, Beier et al. 2011, Haddad et al. 2015), and is increasingly considered in conservation methodologies (Beier et al. 2008, Lentini et al. 2013).

Several recent studies show that to design efficient, practical conservation strategies, it is crucial to incorporate economic, ecological, and biodiversity considerations from the outset. Dilkina et al. devised an optimization framework for a budget-constrained corridor design problem that simultaneously incorporates spatially explicit models of species-specific resistances and spatially heterogeneous economic costs of conservation actions; they applied it to a case study of corridor design for wolverines and grizzly bears in western Montana.

Dilkina et al. found that designing corridors for single species based on purely ecological criteria can lead to expensive linkages that are suboptimal for multispecies connectivity objectives. Alternately, acquiring land only for the least-expensive corridor leads to ecologically poor solutions. By imposing cost-constraints on the ecological optimization process, they achieved linkages with much better ecological values given budget constraints marginally above the feasible minimum-expenditure corridor design. Similarly, joint optimization for multiple species led to better connectivity while matching the acquisition costs associated with multiple individual-species corridor designs.

Dorresteijn I, Hanspach J, Kecskes A, Latkova H, Mezey Z, Sugar S, von Wehrden H, Fischer J. 2014. Human-Carnivore Coexistence in a Traditional Rural Landscape. *Landscape Ecology* 29: 1145-55. DOI: 10.1007/s10980-014-0048-5.

While studies show that human-carnivore coexistence is possible, efforts are often hampered by human-carnivore conflicts, which can harm rural households especially (Holmern et al 2007). A key to successful conservation is to better understand the dynamics of human-carnivore coexistence, specifically by learning from the landscapes in which carnivores and humans have coexisted over time.

Using Transylvania as their study site, Dorresteijn et al. analyzed spatial patterns of bear activity in response to anthropogenic and biophysical variables, as well as local and regional ecological connectivity. They also interviewed local shepherds, villagers, and community representatives to assess attitudes toward the bears. Dorresteijn et al. found an apparent balance between humans and bears in this study site due to the availability of large blocks of habitat; use of traditional livestock husbandry techniques that minimized damage from bears; and some tolerance for occasional conflict.

Dorresteijn I, Milcu AI, Levenon J, Hanspach J, Fischer J. 2016. Social Factors Mediating Human-Carnivore Coexistence: Understanding Thematic Strands Influencing Coexistence in Central Romania. *Ambio* 45(4):490-500. DOI:10.1007/s13280-015-0760-7.

To design effective tools that facilitate coexistence, studies need to account for the complexity of social factors that shape it (Dickman 2010). Despite an increasing recognition of the need to integrate social science into understand the extent of human-carnivore conflicts (Carter et al. 2012, Inskip et al. 2014),

the majority of studies to date have described conflicts or attitudes toward carnivores; whereas fewer studies have focused on the underlying drivers and impacts of conflict (Barua et al. 2013, Can et al. 2014, Madden and McQuinn 2014).

In Europe, such knowledge is particularly important because recent expansions of brown bear populations have caused increased conflicts (Enserink and Vogel 2006, Can et al. 2014), and illegal killing would undermine the recovery of bear populations (Ciucci and Boitani 2008, Kaczensky et al. 2011). To understand coexistence, regions where humans and carnivores have successfully co-occurred for a long time can provide particularly useful case studies (Boitani 1995).

Dorresteijn et al. conducted semi-structured interviews in Central Romania to explore human-bear coexistence and identified three socially mediated thematic strands, which showed different ways in which perceived interactions between people, bears, and environment shape coexistence—landscape-bear, landscape-human, and management.

All three strands highlight both threats and opportunities for peaceful coexistence. The authors argue that management and policy interventions could be improved by systematically considering the possible effects of interventions on each of the strands, and suggest that future research should explore the relevance of the identified thematic strands in other settings worldwide.

Elfstrom M, Zedrosser A, Stoen O-G, Swenson JE. 2014. Ultimate and Proximate Mechanisms Underlying the Occurrence of Bears Close to Human Settlements: Review and Management Implications. *Mammal Review* 44:5-18. DOI:10.1111/j.1365-2907.2012.00223.x.

Large carnivores found near human settlements, and accessing human-derived foods—from livestock to garbage—are often considered “unnatural” and their existence forms a major obstacle for conserving large carnivore populations. However, bears have also been observed near human settlements without accessible human-derived foods, or without utilizing available human-related foods (McCullough 1982).

Focusing primarily on the brown bear, Elfstrom et al. analyzed previously published scientific data to determine ultimate and proximate mechanisms underlying the occurrence and behavior of bears near people, and specifically related to sex, age, and reproductive categories.

Elfstrom et al. found that bear behavioral strategies including avoidance of intraspecific aggression explain the type of bears occurring near humans better than naivety, human habituation, or food condition. Bears approaching human settlements should not be considered unnatural but, rather, individuals showing an adaptive behavior and using predation refuges as an ultimate mechanism of bears' despotic distribution.

Evans MJ, Hawley JH, Rego PW, Rittenhouse TAG. 2014. Exurban Land Use Facilitates Human-Black Bear Conflicts. *Journal of Wildlife Management* 78(8):1477-85. DOI:10.1002/jwmg.796.

The distribution and arrangement of habitats and human use areas are important to understanding where and why conflicts with wildlife occur; such data may inform proactive management activities to

minimize conflicts. Black bear abundance and the number of human-black bear conflicts are increasing in the northeast United States, particularly in developed areas.

Evans et al. applied a spatial modeling approach to identify landscape variables associated with spatial intensity of human-black bear conflicts in Connecticut, and predicted where conflicts were most likely to occur in the future.

Likely conflict locations were determined by percent of forest cover and proportion of such forest classified as edge habitat. The authors attribute these results to Connecticut's exurban landscape, typical of New England, in which housing and natural land cover are extensively interspersed, as opposed to housing fragmenting natural land cover.

The authors suggest that these findings can inform town planners and developers in designing future housing to proactively minimize human-black bear conflicts. They also identified areas of high risk for conflict; the extent of these areas can help determine the scale of bear management units within which different management approaches are applied.

Fernandez-Gil A, Naves J, Ordiz A, Quevedo M, Revilla E, Delibes M. 2016. Conflict Misleads Large Carnivore Management and Conservation: Brown Bears and Wolves in Spain. *PLoS ONE* 11(3):e0151541. DOI:10.1371/journal.pone.0151541.

When two or more large carnivore species are sympatric, the mixture between objective (ecological, economic) and subjective (cultural, emotional) components may lead to particularly complex diagnosis for conservation and management, as one species may suffer disproportionate negative human attitudes, unrelated to the actual magnitude of damages (Frank et al. 2005, Roskaft et al. 2007).

In northwest Spain, brown bears are strictly protected, whereas wolves are subject to lethal control. Fernandez-Gil et al. explored ecological, economic and societal components of conflict scenarios involving large carnivores and damages to human properties. They analyzed the relation between complaints of depredations by bears and wolves on beehives and livestock, respectively, and bear and wolf abundance, livestock heads, number of culled wolves, amount of paid compensations, and media coverage. They also evaluated the efficiency of wolf culling to reduce depredations on livestock.

Bear damages to beehives correlated positively to the number of female bears with cubs of the year. Complaints of wolf predation on livestock were unrelated to livestock numbers; instead, they correlated positively to the numbers of wild ungulates harvested during the previous season, the number of wolf packs, and to wolves culled during the previous season.

Compensations for wolf complaints were fivefold higher than for bears, but media coverage of wolf damages was thirtyfold higher. Media coverage of wolf damages was unrelated to the actual costs of wolf damages, but the amount of news correlated positively to wolf culling. However, wolf culling was followed by an increase in compensated damages. The authors argue their results show that culling of the wolf population failed in its goal of reducing damages, and suggest that management decisions are at least partly mediated by press coverage. They suggest that management may be reactive to perceived conflicts.

Fremier AK, Kiparsky M, Gmur S, Aycrigg J, Craig RK, Svancara LK, Goble DD, Cosens B, Davis FW, Scott JM. 2015. A Riparian Conservation Network for Ecological Resilience. *Biological Conservation* 191: 29-37. DOI: 10.1016/j.biocon.2015.06.029.

A crucial gap exists between the static nature of existing protected areas in the U.S. and the dynamic impacts of 21st century stressors, including habitat loss and fragmentation and climate change. Connectivity is a valuable element for bridging the gap and building the ecological resilience of existing protected areas; however, creating terrestrial connectivity by designing individual migration corridors across fragmented landscapes is arguably untenable at a national scale.

Fremier et al. explored the potential for use of riverine corridors in a riparian connectivity network (RCN) as a potential contributor to a more resilient network of protected areas. They found that the spatial backbone for an RCN is already in place, and that such networks could connect protected areas and have a higher rate of conservation management than terrestrial lands. Further, they suggest that conservation is better served if riparian connectivity is part of a larger landscape connectivity strategy.

Gehring TM, VerCauteren KC, Landry J. 2010. Livestock Protection Dogs in the 21st Century: Is an Ancient Tool Relevant to Modern Conservation Challenges? *BioScience* 60(4):299-308. DOI:10.1525/bio.2010.60.4.8.

Livestock protection, or guarding, dogs (LPD) function as disruptive-stimulus tools to repel predators. They also function as aversive-stimulus tools that can cause predators to modify their behavior. As such, they can be among the most efficient tools for reducing predator-livestock conflicts. They can be used as proactive prevention tools and to reduce reliance on reactionary conflict management. LPDs can also confer psychological benefits to producers by lowering stress and perceived-threat levels.

LPDs have been reported to lower sheep depredations by brown and black bears, as well as mountain lions. There is conflicting testimony regarding relative effectiveness of LPDs in fenced pasturage as opposed to open-range ranches, although they seem to be least effective where livestock are widely dispersed (not flocked/herded) and where producers spend only minimal time monitoring their livestock. Cost benefit analyses suggest that the majority of producers using LPDs value them as economic assets.

There are not many quantitative studies of LPDs. Almost all research is anecdotal and qualitative. Most empirical evidence involves sheep and coyotes, with positive results. The primary consensus is that LPDs are good at protecting livestock against predation, and that money is saved and depredation decreases when LPDs are present.

Gehring et al. argue that LPDs can help prevent depredation before it becomes a problem. They recommend that LPDs be used with a combination of other methods for protection, but point out that LPDs can allow producers to be more self-reliant in protecting their own livestock.

Gehring TM, VerCauteren KC, Cellar AC. 2011. Good Fences Make Good Neighbors: Implementation of Electric Fencing for Establishing Effective Livestock-Protection Dogs. *Human-Wildlife Interactions* 5(1):106-11.

To be effective, livestock protection dogs (LPD) must defend livestock from predators, and to do so they must stay with livestock. Many existing guidelines stress the importance of bonding dogs to livestock. Although strong socialization is paramount for success, socialization alone may not prevent unattended dogs from roaming.

Gehring et al. suggest that electric fencing maintained for livestock can be a particularly effective tool in this regard, and may require only slight modifications for purposes of preventing roaming behavior in protection dogs. Proper training of dogs around electric fencing is critical in this process. In operations that already utilize electric fencing to manage grazing, this infrastructure can be applied to training and managing protection dogs.

Gunther KA, Haroldson MA, Frey K, Cain SL, Copeland J, Schwartz C. 2004. Grizzly Bear-Human Conflicts in the Greater Yellowstone Ecosystem, 1992-2000. *Ursus* 15(1):10-22. DOI:[http://dx.doi.org/10.2192/1537-6176\(2004\)015<0010:GBCITG>2.0.CO;2](http://dx.doi.org/10.2192/1537-6176(2004)015<0010:GBCITG>2.0.CO;2).

For many years, translocation was the common solution for managing individual grizzly bears that came into conflict with humans. This usually provided only temporary alleviation instead of long-term solutions. Gunther et al. argue that wildlife managers need to be able to predict the proximal causes, types, locations, and trends of conflicts in order to more efficiently allocate limited resources for proactive rather than reactive management actions. They recorded and analyzed trends in grizzly bear-human conflicts over time, in and around the Yellowstone Grizzly Bear Recovery Zone (YGBRZ).

Numbers of conflicts generally increased from spring through early and late hyperphagia, and livestock depredations peaked during early hyperphagia. The number of conflicts involving property damage and anthropogenic foods, human injuries, gardens and orchards, and beehives all had similar patterns—peaking during late hyperphagia.

Occupied grizzly bear range has expanded dramatically over the past 30 years. Gunther et al. predict that depredations and conflicts will likely continue to increase if the area occupied by bears continues to increase and overlap areas of human use and habitation.

The authors make special note that the majority of recorded grizzly bear-human conflicts occurred in six locations of human activity. Identifying and targeting conflict hotspots such as these is a wise use of resources. Most livestock depredations involved cattle, and almost all of those depredations occurred in Wyoming (very few occurred in Montana, despite presence and range overlap between bears and cattle). If current practices in Wyoming might be changed to reduce depredations, this would be a cost-effective benefit to livestock producers there.

The authors note that permanent removal of chronic depredators has been an effective method of alleviating livestock losses while having minimal impact on the long-term survival of the broader population. Additionally, they note that grizzly bears and domestic sheep are not generally compatible, and the authors recommend incentivizing the retirement of sheep grazing allotments that are

positioned in important core grizzly bear habitats. They recommend use of electric fence to protect vulnerable livestock such as sheep on bed-grounds, as well as to deter bears from garbage, beehives, and other attractants. The authors also suggest the strategic use/expansion of food and garbage storage orders in conflict-prone areas.

Gunther KA, Shoemaker RR, Frey KL, Haroldson MA, Cain SL, van Manen FT, Fortin JK. 2014. Dietary Breadth of Grizzly Bears in the Greater Yellowstone Ecosystem. *Ursus* 25(1):60-72. DOI:10.2192/ursus-d-13-00008.1

Grizzly bears in the Greater Yellowstone Ecosystem (GYE) are opportunistic omnivores that eat a great diversity of plant and animal species. Changes in climate may affect regional vegetation, hydrology, insects, and fire regimes, likely influencing the abundance, range, and elevational distribution of the plants and animals consumed by GYE grizzly bears.

Determining the dietary breadth of grizzly bears is important to document future changes in food resources and how those changes may affect the nutritional ecology of grizzlies.

Gunther et al. conducted a review of available literature and compiled a list of species consumed by grizzly bears in the GYE. They documented more than 266 species within 200 genera from 4 kingdoms, including 175 plant, 37 invertebrate, 34 mammal, 7 fungi, 7 bird, 4 fish, 1 amphibian, and 1 algae species, as well as 1 soil type consumed by GYE grizzly bears.

Harihar A, Verissimo D, MacMillan DC. 2015. Beyond Compensation: Integrating Local Communities' Livelihood Choices in Large Carnivore Conservation. *Global Environmental Change* 33: 122-30. DOI: 10.1016/j.gloenvcha.2015.04.004.

Conserving biodiversity in human-dominated regions of the world is complex, particularly in the case of large carnivores where perceived conflicts exist with economic development, expanding human populations, and livelihoods. Using a systematic bottom-up consultative framework, based on a choice modelling approach that accounts for heterogeneity in the population, Harihar et al. explored alternative strategies that meet conservation and human development goals.

Focusing on a pastoralist community in northern India, their research identified the community's preferred government support measures to encourage coexistence with tigers. The authors found that direct losses from predation were secondary concerns compared to development measures despite these losses being comparable to other tiger landscapes. Further, they found that almost all sampled households preferred resettlement over any form of coexistence, with positive preferences for larger land sizes, the immediate and permanent transfer of property rights, a government-built house, and the potential to generate a living from agro pastoralism.

As resettlement would avoid conflict with tigers and lead to habitat and prey recovery, it follows that tiger conservation and human development goals could be best realized by securing vast areas of inviolate tiger habitat through community resettlement to acceptable locations away from tiger habitat. Although Gujjars (in this case study) preferred resettlement as a way forward, the authors highlight the

need for a responsive policy and institutional framework that can accommodate local needs and ensure there are adequate opportunities for creation of sustainable livelihoods within tiger habitat. More generally, they show how different outcomes for tigers and humans can be explored empirically to generate better outcomes for carnivores and people at a landscape scale.

Hebblewhite M. 2011. Unreliable Knowledge about Economic Impacts of Large Carnivores on Bovine Calves. *Journal of Wildlife Management* 75(8):1724-30. DOI:10.1002/jwmg.206.

Hebblewhite critiques a study situated in western Wyoming's Upper Green River Allotment, which concluded that recolonizing predators increase bovine calf mortality rates. The authors of that study compared calf loss rates before and after carnivore recovery, and concluded that increasing wolf and grizzly bear populations increased calf losses.

Hebblewhite's third-party re-analysis of the data revealed a much more nuanced picture complicated by a statistically confounded set of factors. He found that calf loss rates were a result of stocking densities, precipitation, area, reporting rate bias, *as well as* predation during periods when wolves and grizzly bears were present.

Stocking density is perhaps the most important husbandry practice that can be modified by ranchers, and it affects both adult and calf productivity and weight gain. Predation and food competition can both be density dependent. Low summer precipitation also increases calf loss rates, which may suggest that drought effects render calves more susceptible to mortality. This is also consistent, however, with predator-induced stress hypotheses. These 3 potential mechanisms are all consistent with increasing susceptibility of calves to predation, and highlight the weakness of observational studies in revealing mechanistic explanations for mortality patterns.

Hebblewhite points out that the personal values of stakeholders can also contribute to increased perceptions of conflict when none in fact exist. His reanalysis found some support for such an observer expectancy bias. His discussion highlights the complexity of causal factors related to livestock-carnivore conflict and predation. Results-based analysis should generally be examined carefully, precisely because of the behavioral and biological complexity associated with predation.

Hiller TL, McFadden-Hiller JE, Jenkins SR, Belant JL, Tyre AJ. 2015. Demography, Prey Abundance, and Management Affect Number of Cougar Mortalities Associated with Livestock Conflict. *Journal of Wildlife Management* 79(6):978-988. DOI:10.1002/jwmg.913.

As some large carnivore populations recover because of conservation efforts, managing livestock-carnivore and human-carnivore conflicts to the satisfaction of all stakeholders has become increasingly challenging, especially in regard to cougars, which are not viewed as favorably as other carnivores (Kellert et al. 1996). To inform decisions for balancing social and ecological considerations in cougar management, Hiller et al. assessed factors associated with number of cougars killed due to livestock conflicts. Factors considered included wild and domestic prey availability, land cover, human population, hunter harvest, and other characteristics. Assessment was conducted on data gathered between 1990 and 2009 at the county level in the state of Oregon.

Focusing on cougar density, Hiller et al. found that cougar mortalities resulting from livestock conflicts did not increase as the density of cougars harvested increased when the estimated cougar population was at minimum (30/10,000 km²) or mean (200/10,000 km²) values, and remaining independent variables were held constant at their respective mean values. However, when the estimated cougar population density was at maximum (500/10,000 km²), the density of cougar mortalities related to livestock conflicts decreased with increasing harvest density.

Although Hiller et al. could not provide evidence of a causal relationship, mortality densities related to hunter harvest and to conflicts with livestock appear to have an inverse relationship within the limits of their data. These results indicate that hunter harvest may be a useful tool in managing conflicts under some circumstances, such as in Oregon. Additional strategies could include removing some or all livestock from areas of low deer density, decreasing deer harvest, or increasing prey densities.

Inskip C, Carter N, Riley S, Roberts T, MacMillan D. 2016. Toward Human-Carnivore Coexistence: Understanding Tolerance for Tigers in Bangladesh. *PLoS ONE* 11(1):e0145913. DOI:10.1371/journal.pone.0145913.

Across increasingly human-dominated landscapes, fostering local community tolerance for wildlife is a core component of conservation strategies for many endangered species (Bruskotter and Wilson 2013, Treves and Bruskotter 2014, Ripple et al. 2014, Carter et al. 2012). Large carnivores which (are perceived to) present a threat to people, livestock, pets, or game species are particularly likely to engender low levels of tolerance in local communities (Kansky et al. 2014, Naughton-Treves and Treves 2005). Such intolerance for carnivores, manifest most obviously in lethal control practices, long has been associated with species' population declines and extinctions (Kellert et al. 1996, Woodroffe et al. 2005). Building community tolerance for large carnivores, therefore, is key to carnivore persistence, yet presents a persistent challenge worldwide for effective conservation (Ripple et al. 2014, Dickman 2010).

Inskip et al. explored villagers' tolerance for tigers in the Bangladesh Sundarbans, where human-tiger conflict was severe. They found that beliefs about tigers and about the perceived current tiger population trend were predictors of tolerance for tigers. Positive beliefs about tigers and a belief that the tiger population was not increasing were both associated with greater stated tolerance for the species. Contrary to commonly held notions, negative experiences with tigers did not directly affect tolerance levels; instead, their effect was mediated by villagers' beliefs about tigers and risk perceptions concerning human-tiger conflict incidents.

The authors suggest that their findings highlight a need to explore and understand the socio-psychological factors that encourage tolerance toward endangered species.

Jacobs CE, Main MB. 2015. A Conservation-Based Approach to Compensation for Livestock Depredation: The Florida Panther Case Study. *PloS One* 10(9). DOI:10.1371/journal.pone.0139203.

Conflict between large carnivores and humans is a global issue that has become an important aspect of large carnivore conservation. Livestock depredation is often the principal reason for this conflict and can

lead farmers to kill predators in retaliation or as a preventative measure (Inskip and Zimmerman (2009) As a result, livestock depredation is considered one of the driving forces behind the worldwide decline of large carnivores (Inskip and Zimmerman 2009, Nelson 2009, Ripple et al. 2014). While compensation programs are often established to address the issue of livestock depredation, some of the most common programs are highly criticized due to problems such as moral hazard (Swenson and Anden 2005, Zabel and Holm-Muller 2008), high transaction costs (Sabervall et al. 1994), unconfirmed losses, and the difficulty of finding depredations (Zabel and Holm-Muller 2008, Montag 2003). It is therefore important to consider new approaches to compensation programs in order to conserve and, where needed, recover large carnivore species.

Jacobs and Main studied the impact of panthers on the ranching industry to quantify calf depredation, and to develop a habitat suitability model to evaluate the quality of panther hunting habitat on ranchlands, assess whether the model could predict predation risk, and discuss its potential for inclusion in an incentive-based compensation program.

Jacobs and Main found that if large carnivore conservation and recovery is dependent on maintaining suitable habitat on private lands, strategies designed to compensate and incentivize landowners for managing large carnivore habitat will promote conservation efforts. Their panther hunting habitat model represents an approach that may be useful for addressing livestock depredation conflicts for other carnivores and areas worldwide by providing a means to prioritize and categorize private lands for participation in a PES program that incentivizes the conservation of large carnivore habitat and compensates landowners for the associated risks to livestock.

Jacobsen KS, Linnell JDC. 2016. Perceptions of Environmental Justice and the Conflict Surrounding Large Carnivore Management in Norway – Implications for Conflict Management. *Biological Conservation* 203:197-206. DOI:10.1016/j.biocon.2016.08.041.

Human-wildlife conflict (HWC) scholars are increasingly realizing that HWC also results in human-human conflict as groups of people with contrasting views on wildlife conservation struggle to shape policy according to their preferences (Treves and Karanth, 2003, Dickman, 2010 and Redpath et al., 2013). Conflicts that are superficially concerned with antagonisms between wildlife and humans are frequently characterized by underlying human-human social conflict. At its most basic level, this social conflict involves groups of people with different values or goals (Madden, 2004).

Norway is a particularly interesting case, as it presents a scenario that combines livestock (sheep and semi-domestic reindeer) husbandry practices that are extremely susceptible to predation from naturally recovering populations of large carnivores in a period of societal change in rural areas. Jacobsen and Linnell investigated perceptions of justice regarding the carnivore conflict in Norway among sheep farmers, environmentalists, and indigenous reindeer herders.

The authors found that the widest disagreement was over what constitutes environmental harm and environmental goods, and how the costs and benefits should be distributed, indicating that fundamental differences in values and perceptions underlie the intractability of this conflict. Jacobsen and Linnell suggest their results confirm the common assumption that carnivore conflict in Norway is highly polarized, and decisions regarding management of carnivores is going to entail political prioritization of one viewpoint over the other.

Jochum KA, Kliskey AA, Hundertmark KJ, Alessa L. 2014. Integrating Complexity in the Management of Human-Wildlife Encounters. *Global Environmental Change* 26:73-86. DOI:10.1016/j.gloenvcha.2014.03.011.

Along with urbanized landscapes and human population growth, the difficulty of predicting human behavior, coupled with changes in human behavior over space and time, and additional scales (Cash et al. 2006), are major challenges for today's wildlife managers. Conservation not only aims to increase wildlife population size, but also to maintain biological diversity, thereby keeping wildlife at sustainable population levels. In addition, there has risen a growing demand for more robust theories and methodologies to enable and guide effective human-wildlife management.

Jochum et al. argue that human-wildlife encounters can only be understood and modified toward resilient relationships when treated as a complex social-ecological system, but no structured behavior theory exists on how to address these management challenges.

This study, using their Integrated Adaptive Behavior Model, is a first attempt to do so through assembling and analyzing existing social-psychological, human-environment, and human-wildlife behavior theories and models in regard to their relevance to human-wildlife encounters.

Johansson M, Frank J. 2016. The Impact of Access to an Ultrasonic Scaring Device on Human Fear of Wolves. *Wildlife Biology* 22(2):29-36. DOI:10.2981/wlb.00154.

The increase of wolves in Scandinavia is associated with socioecological conflicts, and the conservation and management of this species is as much a political and sociocultural challenge as a biological matter. One component in this conflict is people's feeling of fear, but there have been very few evaluations of management interventions aimed at addressing human fear of wolves.

Johansson and Frank evaluated the effect of access to a hand-held ultrasonic scaring device, for six months, to people living in wolf territories. The authors found no significant effect on participants' appraisal of wolves, trust in managing authorities, or self-reported fear. In depth interviews with some people who declined the invitation to have access to the device revealed that the device was considered an irrelevant solution to the conflict, and that people lacked trust in the technology.

The authors conclude that the potential in using an ultrasonic device to reduce fear of wolves seems very limited in the present context. Further interventions to address human fear must be identified in dialogue with people affected, and should preferably be based on psychological principles.

Johansson M, Merreira IA, Stoen O-G, Frank J, Flykt A. 2016. Targeting Human Fear of Large Carnivores—Many Ideas but Few Known Effects. *Biological Conservation* 201():261-69. DOI:10.1016/j.biocon.2016.07.010.

There is a range of potential management measures aimed at reducing the number of interactions between humans and large carnivores, such as fencing livestock, removing attractants, and hunting (Shivik 2014). The acceptability of such measures, in particular lethal management, is partly associated

with human emotions, including feelings of fear (Jacobs et al. 2014, Lute et al. 2014, Pohja-Myrkä and Kurki 2014). However, evaluations of the effectiveness of these management measures rarely address the social or human aspects, such as the potential to reduce individual feelings of fear (Treves et al. 2009, Maheshwari et al. 2014, Frank et al. 2015).

In the literature, interventions are frequently proposed for addressing negative human responses to large carnivores, but little is known about the actual potential to reduce people's fear (Gore et al. 2006, Gusset et al. 2008).

Johansson et al. reviewed the scientific literature on interventions put forward to reduce human fear of large carnivores, with the objective of summarizing the current state of knowledge. The authors defined interventions as any action to mitigate human-large carnivore conflict that may be initiated or used by an individual person, an organization, or an authority. In this context, they considered conflicts as any undesired interaction, direct or indirect, between human and large carnivore.

The authors identified four major categories of intervention, each of which has the potential to reduce fear responses. They consider the literature on the effect of interventions address human fear of large carnivores to be scared and partly contradictory, which they suggest makes it difficult for wildlife managers to rely on current research when designing appropriate interventions.

Karlsson J, Sjostrom M. 2011. Subsidized Fencing of Livestock as a Means of Increasing Tolerance for Wolves. *Ecology and Society* 16(1):16-25.

Studies of how proactive measures to reduce livestock depredation by carnivores affect human tolerance toward carnivores are extremely rare. Nevertheless, substantial amounts of money are spent each year on proactive measures to facilitate large carnivore conservation.

Karlsson and Sjostrom assessed how subsidies for proactive measures to reduce sheep losses to wolves are associated with public attitudes toward wolves. The authors combined wolf territory level information regarding proactive subsidies and wolf attacks on dogs and sheep with geographical information of the respondents—enabling them to assign respondents to a specific wolf territory.

The authors found that the number of wolf attacks on sheep and dogs in the respective territories as well as the number of years that the wolf territory had existed did not affect human attitudes toward wolves. Subsidies for proactive measures to reduce wolf predation on sheep significantly increased positive attitudes toward wolf presence on the local scale. The magnitude of the effect of subsidies for proactive measures was comparable to the effect of other variables well known to affect human attitudes toward wolves such as age or education.

Karlsson and Sjostrom's data show that subsidies not only made the already positive more positive, but also made people with negative attitudes to local wolf presence less negative. The authors argue that subsidies for proactive measures are an effective tool when working with the human dimension of conservation biology.

Karlsson J, Sjoström M. 2007. Human Attitudes towards Wolves, a Matter of Distance. *Biological Conservation* 137:610-616. DOI:10.1016/j.biocon.2007.03.023.

Do people who live closer to wolves have more negative attitudes toward them than their counterparts who live farther away? An individual's orientation to wolves is influenced by complex and nuanced factors, but a spatial relationship between attitudes and proximity is intuitive.

Karlsson and Sjoström examined the relationship between peoples' proximity to wolves and their attitudes toward wolves, using multiple regression with socioeconomic variables (in Sweden).

The authors found that people living closer to wolves generally had a less favorable view of them. Distance to nearest wolf territory seemed to affect attitudes just as much as membership in a conservation organization, being a hunter, owning livestock, or owning a hunting dog. This was true even at a micro-level (people living within wolf territories had more negative views of wolves than people living just outside those territories).

Karlsson and Sjoström do not infer that the direct experience of living in proximity to wolves causes less positive attitudes. They suggest a more complicated relationship, given that few people, even inside wolf territory, have had direct experiences with wolves. Having seen or interacted with a wolf did not appear to affect attitudes. The authors suggest that indirect experience may have a much more powerful effect on attitudes than direct experience of wolf presence. In other words, that intrapersonal contact through friends, peers, or through the media is the primary driver for negative attitudes. They postulate that self-reinforcing negative narratives/interactions about wolves become more common inside wolf territories.

Kendall KC, Stetz JB, Boulanger J, Macleod AC, Paetkau D, White GC. 2009. Demography and genetic structure of a recovering grizzly bear population. *Journal of Wildlife Management* 73(1)3-17. DOI:10.2193/2008-30.

Northern Continental Divide Ecosystem (NCDE) grizzly bear populations appear to be growing in terms of abundance, occupied habitat, and connectivity in areas of historically low genetic interchange. It appears that the population has generally remained genetically integrated and connected to Canadian populations. Data collected by Kendall et al. suggest that it has experienced no severe genetic bottleneck, and that connectivity within the population has also remained largely intact.

Recent decreases in genetic differentiation and apparent expanded distribution in the NCDE are consistent with population growth, although there is no comprehensive and reliable ecosystem-wide trend data to compare census data with. The number and distribution of detected females may also bode well for the population. These results suggest that the NCDE grizzly bear population may be faring better than indicated by the USFWS monitoring program.

There does appear to be incipient fragmentation along the major transportation corridor in the NCDE, and unmitigated development along that corridor may lead to reduced gene flow within the NCDE population and reduced connectivity to adjacent populations. Increased traffic volume and development along other transportation corridors in the NCDE carries similar risks. Long-term management strategies

for this population should include ways to facilitate continued genetic interchange across transportation corridors and the associated development that tends to grow along them.

The known human-caused mortality rate in 2004 (when calculated with abundance estimates based on this study's data) was slightly above the 4% level considered sustainable. The 2004 female mortality rate was double the level allowed in the Recovery Plan. This is noteworthy because female survival appears to be the most important driver of population trend.

Kertson BN, Spencer RD, Marzluff JM, Hepinstall-Cymerman J, Grue CE. 2011. Cougar Space Use and Movements in the Wildland-Urban Landscape of Western Washington. *Ecological Applications* 21(8):2866-81. DOI:10.1890/11-0947.1.

Residential development of natural landscapes is substantial and influential. This development affects the long-term viability of many wildlife species. Although they are primarily associated with wildlands, cougars can and do use areas with an extensive human presence. Understanding the spatial ecology of cougars along a gradient of human residential development—in order to decrease the occurrence of cougar-human interactions—is a principal challenge for cougar managers. Cougars are considered habitat generalists, but the presence of sufficient prey, along with landscape cover for stalking, resting, and rearing young, are usually prerequisites for use.

Kertson et al. examined cougar space use and movement in a mixed wildland-residential study area in western Washington, USA. They found that cougars concentrated their use in prey-rich areas with advantageous foraging characteristics and a limited anthropogenic presence. Maximizing predation opportunities and minimizing exposure to residential development appear equally important to cougars in a wildland-urban environment, and may not be mutually exclusive. Cougars in this setting use the landscape in ways that minimize the potential for interactions with people while remaining consistent with their role as an apex predator in Pacific Northwest ecosystems. Cougars appeared to employ a flexible hunting strategy using areas where principal and alternative prey species are abundant and/or vulnerable.

Lethal control is often the default management strategy to reduce cougar-human interactions. The authors argue that this strategy is incomplete, because it fails to account for cougar spatial ecology. Removal of individual cougars in higher quality habitats could increase cougar use because a home range vacancy increases the probability of use by multiple individuals, until residency of a single individual is established. The authors argue that a better strategy may be found in improved landscape planning. They describe the relevant features of such an approach, and make recommendations for how human development should be implemented.

Knopff AA, Knopff KH, St. Clair CC. 2016. Tolerance for Cougars Diminished by High Perception of Risk. *Ecology and Society* 21(4):33-41. DOI:10.5751/ES-08933-210433.

Low tolerance for cougars in modified landscapes has been identified as a key factor that could restrict continued cougar range expansion in North America, or even reverse some of the gains made by cougar populations in recent decades. To better understand factors influencing tolerance and identify

opportunities to improve conservation prospects for cougars, Knopff et al. implemented a questionnaire in west-central Alberta, where both human and cougar populations have increased over the past 20 years and where they had developed a resource selection function for cougars from telemetry data.

Respondents overestimated risk from cougars, and more than half believed cougars posed the same or greater risk as driving a car, even though only one Albertan has been killed by a cougar in the last century and hundreds die in car accidents each year. Although respondents valued cougars highly, they indicated that cougars belonged in the wilderness and not near their homes.

Knopff et al. predicted that tolerance for cougars would be negatively correlated with increased probability of cougar selection near the respondent's home, but that prediction was not supported. Although such correlations have been reported at broader spatial scales, the authors suggest they may break down at finer scales. Other factors, such as education, were important drivers of tolerance for cougars in Alberta.

The authors suggest that education undertaken to improve large carnivore conservation should focus on accurately defining the risks and ecological benefits resulting from maintaining cougars on the landscape. Education may also need to focus on the importance of non-wilderness habitats (i.e., the rapidly expanding backyard) as an important part of long-term conservation and continued range expansion and repatriation of adaptable large carnivores, such as cougars.

Koziarski A, Kissui B, Kiffner C. 2016. Patterns and Correlates of Perceived Conflict between Humans and Large Carnivores in Northern Tanzania. *Biological Conservation* 199:41-50. DOI:10.1016/j.biocon.2016.04.029.

In East Africa, large carnivores receive a severely negative perception by many local people (Okello 2005, Romanach et al. 2011), largely because they are considered a key antagonist of livestock and livestock represent a vital part of Maasai culture as people depend on them for sustenance, status, and a form of currency (Hampson et al. 2015). The loss of livestock can represent a substantial detriment to a family's yearly income (Loibooki et al. 2002); frequently, large carnivores are killed in response to these losses (Ikanda and Packer 2008).

While the influence of socioeconomic factors in wildlife conservation is acknowledged (e.g. Kolowski and Holekamp, 2005), there is currently limited discussion on how these factors influence perceived conflicts with different large carnivore species across landscapes (Dickman et al. 2014, Hampson et al. 2015). If these factors are affecting not only locals' vulnerability to conflict, but the way they perceive conflict, they are vital to consider when forming and implementing large carnivore management plans and conflict mitigation approaches.

Koziarski et al. identified temporal, spatial, and socioeconomic factors affecting perceived human-carnivore conflicts in a diverse conservation landscape of Northern Tanzania, to determine if perceived conflict would be greatest during the wet season as compared to dry season, in closer proximity to protected areas, and for people of a lower socio-economic status.

The authors found few consistencies among correlates for reported conflict frequency. Ethnicity, gender, age, education, and fear of large carnivores had mixed effects on perceived conflict frequency,

while livestock ownership and relative wealth had negligible impacts. The authors argue that education and psychological and demographic attributes were more influential than economic considerations. They suggest that mitigation strategies that address local needs be made more accessible, and that conservation education programs particularly target conflict hotspots.

Kubasiewicz LM, Bunnefeld N, Tulloch AIT, Quine CP, Park KJ. 2016. Diversionary Feeding: An Effective Management Strategy for Conservation Conflict? *Biodivers Conserv* 25(1):1-22. DOI:10.1007/s10531-015-1026-1.

In response to human-wildlife and wildlife-wildlife interactions, stakeholders often try to manage the landscape to mitigate adverse impacts either on biodiversity or on economic output. However, where multiple land use objectives or differing conservation values lead to stakeholder disagreement on the best way to mitigate adverse impacts, conservation conflicts arise (Young et al. 2010, Redpath et al. 2013).

Kubasiewicz et al. reviewed one management approach used in mitigation for a range of wildlife impacts—diversionary feeding. They define this method as: the use of food to divert the activity or behavior of a target species from an action that causes a negative impact, without the intention of increasing the density of the target population

The authors found that success varied greatly among studies and successful uptake of diversionary food did not consistently produce outcomes that met stakeholder objectives. Studies often failed to report results in sufficient detail to allow a quantitative evaluation of efficiency. The authors propose a decision-making framework that incorporates ecological knowledge, financial costs, and evidence from previous studies to aid in planning and implementing of diversionary feeding in an adaptive format.

Lacher I, Wilkerson ML. 2013. Wildlife Connectivity Approaches and Best Practices in U.S. State Wildlife Action Plans. *Conservation Biology* 00(0):1-9. DOI:10.1111/cobi.12204.

As habitat loss and fragmentation threaten biodiversity on large geographic scales, creating and maintaining connectivity of wildlife populations is an increasingly common conservation objective. To assess the progress and success of large-scale connectivity planning, conservation researchers need a set of plans that cover large geographic areas and can be analyzed as a single data set; state wildlife action plans (SWAPs) fulfill these requirements.

Lacher and Wilkerson examined 50 SWAPs to determine the extent to which wildlife connectivity planning, via linkages, is emphasized nationally. They defined linkages as connective land that enables wildlife movement, and identified and quantified keywords and content criteria. They found only 30% or less of the SWAPs fulfilled highly specific content criteria. They found positive correlations between their content criteria and statewide data on percent conserved land, total focal species, and spending on parks and recreation.

Lacher and Wilkerson's results reflected nationwide disparities in linkage conservation priorities and highlight the continued need for wildlife linkage planning. The authors suggest some best practices for wildlife linkage conservation plans.

Lamb CT, Mowat G, McLellan BN, Nielsen SC, Boutin S. Forbidden Fruit: Human Settlement and Abundant Fruit Create an Ecological Trap for an Apex Omnivore. *Journal of Animal Ecology* 86(1):55-65. DOI:10.1111/1365-2656.12589.

Animals tend to use a series of cues established over evolutionary time to select habitats that maximize their fitness (Darwin 1859, Fretwell and Lucas 1970). However, maladaptive habitat selection can occur when novel conditions decouple the link between habitat quality and fitness, resulting in an ecological trap or ET (Dwernychuk and Boag 1972). ETs and human activity are often associated because human alteration of landscape tends to occur more rapidly than cues evolve to guide an animal's response to landscape changes (Robertson et al 2013, Hale and Swearer 2015).

Apex consumers are highly vulnerable to ETs because they typically lack natural predators and may not perceive or avoid novel sources of risk such as human predation (Robertson et al. 2013). Lamb et al. tested for an ET for grizzly bears using demographic and movement data collected in an area rich with food resources and concentrated human settlement.

They found that a valley high in both berry resources and human density was more attractive than surrounding areas, and bears occupying this region faced 17% lower apparent survival. Despite lower habitat fitness, they detected a net flow of bears into this ET, which contributed to a study-wide population decline. The authors suggest that this study highlights the presence and pervasiveness of an ET for an apex omnivore that lacks the evolutionary cues, under human-induced rapid ecological change, to assess tradeoffs between food resources and human-caused mortality, which results in maladaptive habitat selection.

Lambert CMS, Wielgus RB, Robinson HS, Katnik DD, Cruickshank HS, Clark R, Almack J. 2006. Cougar population dynamics and viability in the Pacific Northwest. *Journal of Wildlife Management* 70(1):246-54. DOI:10.2193/0022-541X(2006)70[246:CPDAVI]2.0.CO;2.

Increasing reports of human-cougar conflicts may suggest that cougars are increasing in the Pacific Northwest—indeed this is a widely accepted belief. Lambert et al. determined minimum relative densities and average fecundity, survival, and growth rate of a cougar population in northeast Washington, northern Idaho, and southern British Columbia.

Contrary to accepted belief, the authors' findings suggest a declining Pacific Northwest cougar population. They describe their demographic/population findings, and postulate that increasing conflicts between cougars and humans in this area could be the result of: (a) the very young age structure of the population, caused by heavy hunting; (b) increased human intrusion into cougar habitat; (c) low level of social acceptance of cougars in the area; and/or (d) habituation of cougars to humans.

Lambert et al. reject that cougars are currently increasing in their study area. They suggest that this decline could be reversed by decreasing harvest rates, especially for adult females, and that wildlife managers should not assume that increasing cougar-human complaints correspond with increasing cougar populations. Indeed, increasing complaints may accompany a rapidly declining population as shown in this area. Sustainable hunting regulations and bag limits should not be based on numbers of cougar complaints, but should be based on reliably estimated demographic trends.

Lambert et al. recommend reduced levels of cougar exploitation, particularly for adult females, and upgraded monitoring and collaborative efforts to accurately account for demographic trends.

Lance NJ, Breck SW, Sime C, Callahan P, Shivik JA. 2010. Biological, technical, and social aspects of applying electrified fladry for livestock protection from wolves. *Wildlife Research* 37:708-14. DOI:10.1071/WR10022.

Management of wolf predation on livestock is an adaptive process that ideally uses a suite of tools. Fladry (interspersed flagging suspended on a single strand of rope or twine) is a barrier tool that has been successfully used to deter wolves from approaching livestock. It is a type of primary repellent that relies on producing a flight response. However, wolves do habituate to fladry, which reduces its effectiveness over time. Electrified fladry is a relatively new variation on the traditional design that incorporates an electric shock in order to decrease the potential for habituation. Electrified fladry appears to offer superior protection compared with non-electrified fladry. In testing that utilized captive wolves, Lance et al. found that electrified fladry was 2 to 10 times more effective than fladry for protecting a food resource.

Electrified fladry is also significantly more expensive than fladry. In terms of overall effectiveness at deterring wolves, as well as these economic costs, Lance et al. suggest that electrified fladry may best be applied to smaller pastures and/or targeted to areas prone to persistent conflict.

Nonlethal tools are often criticized for being time and resource intensive, but lethal alternatives have associated criticisms of their own when considering diverse stakeholders and when costs and benefits are defined more broadly. Lance et al. suggest that non-lethal tools like electrified fladry may be essential for fostering and increasing tolerance of predators, especially when used in combination with other lethal and non-lethal tools.

Laporte I, Muhly TB, Pitt JA, Alexander M, Musiani M. 2010. Effects of Wolves on Elk and Cattle Behaviors: Implications for Livestock Production and Wolf Conservation. *PLoS ONE* 5(8):e11954. DOI:10.1371/journal.pone.0011954.

Prey species often exhibit anti-predator behaviors (e.g., increased vigilance, grouping, changes in movement patterns) in the presence of predators. These behaviors and associated stress can be expected to cause negative physiological effects, such as weight loss and reduced reproduction. Livestock depredation compensation programs typically focus on the market value of animals killed outright. One criticism of these models (and a general complaint of livestock producers in relation to expanding predator populations) is the failure to account for less-visible physiological costs associated

with anti-predator behaviors. Leaving aside the issue of whether anti-predator behaviors are effective at deterring predation, they may result in increased stress, which may leave cattle more vulnerable to infections and disease, abortion and early birth, as well as weight loss, all of which can have a subtle but negative effect on market values.

Laporte et al. monitored herds of cattle, consisting entirely of yearlings, located on a public land grazing allotment. Collared wolves from four different packs were in the area. Behavioral responses were measured before, during, and after known wolf presence in or near cattle pastures. The authors also monitored elk habitat use in relation to wolf presence.

They authors found that individual cattle increased their path sinuosity and decreased their distance to neighbors. Groups of cattle erratically changed speed, increased head-up time, decreased path sinuosity, and decreased their distance to neighbors. However, less than half of wolf visits to pastures prompted a change in a response variable, with no clear pattern. The data imply that there are energetic costs associated with wolf presence. Since wolves seem to affect cattle, it follows that there might be some fitness costs to the cattle. This may yield economic consequences for ranchers.

Laporte et al. note that domestic prey often show weaker behavioral responses to predators than do wild animals, presumably because of human selection for docility as well as the livestock's unfamiliarity with predators. Cattle groups have shown a number of behavioral changes concomitant to wolf visits. Nonetheless, direct fitness costs have not been quantified alongside behavioral observations. There are no direct data relating anti-predator behaviors to physiological consequences. Similarly, inference on presence and importance of anti-predator behaviors in cattle has to be limited. The behavioral and biological complexity associated with predation is very high, and associated variables are often complex and confounding.

Larson LR, Conway AL, Hernandez SM, Carroll JP. 2016. Human-Wildlife Conflict, Conservation Attitudes, and a Potential Role for Citizen Science in Sierra Leone, Africa. *Conservation and Society* 14(3):205-17. DOI:10.4103/0972-4923.191159.

Wildlife can inflict considerable stress on local livelihoods by threatening human life (MacDonald and Sillero-Zubiri 2002), destroying crops (Hill 2000, Granados and Weladji 2012) and attacking livestock (Kissui 2008). Crop destruction by wildlife is particularly costly, often resulting in lost income and lost time spent preventing raiding events (Weladji and Tchamba 2003, McGuinness and Taylor 2014). All of these costs can result in negative attitudes toward wildlife conservation among local people (Gadd 2005, Kideghesho et al. 2007), precipitating enduring conflicts between humans and wildlife (West et al. 2006).

To better understand the nature and extent of these conflicts, Larson et al. solicited local input through a social science inquiry to examine human-wildlife interactions surrounding the Tiwai Island Wildlife Sanctuary in rural Sierra Leone. Results revealed high levels of crop depredation, retaliatory killing, and bushmeat harvesting in villages surrounding the protected area. Larson et al. also found that pro-conservation attitudes were less prevalent among younger adults and immigrants to the region.

The authors also explored use of a Public Participation in Scientific Research (PPSR) framework for monitoring human-wildlife interactions. They suggest that efforts to promote wildlife conservation and

mitigate human-wildlife conflict could focus on younger adults and immigrants (in this case), and should consider PPSR, or Citizen Science, as one strategy for increasing local investment in the process.

Lute ML, Gore ML. 2014. Knowledge and Power in Wildlife Management. *Journal of Wildlife Management* 78(6):60-68. DOI:10.1002/jwmg.754.

Despite a trend toward more transactional processes that purposefully incorporate stakeholder knowledge, technical and science-based information remain dominant inputs for wildlife governance. Thus, most decision-making rests with wildlife managers and politicians, depends on scientific knowledge, and includes varying involvement of local stakeholders. Resultant tension from top-down wildlife governance can result in conflict over stagnated wildlife management decisions. Understanding public perceptions of knowledge and power can help improve management effectiveness that balances top-down and bottom-up approaches.

Lute and Gore used Michigan wolf management as a case study to explore this relationship in regard to delisted endangered species. Through semi-structured interviews of highly involved stakeholders, they qualitatively explored public perceptions related to power inequalities among groups, and the role of scientific knowledge in decision-making associated with hunting wolves in Michigan.

Lute and Gore identified emergent themes including sources of knowledge for decision-making; political power overrides science in decision-making; special interests disenfranchise other publics; and mistrust of decision-makers exists among stakeholders. They argue that further testing and validation of these themes could inform predictive models and inferential studies useful for public participant planning and stakeholder engagement.

Lute ML, Gore ML. 2014. Stewardship as a Path to Cooperation? Exploring the Role of Identity in Intergroup Conflict Among Michigan Wolf Stakeholders. *Human Dimensions of Wildlife* 19(3):267-79. DOI:10.1080/10871209.2014.888600.

Disagreement over how to manage human-wildlife conflict is a challenge for contemporary wildlife management. Integrating human dimensions into wildlife management has provided key insights into understanding what and how people think about human-wildlife conflict, not least of which includes measuring concepts such as social acceptance capacity, support for compensation schemes, or media coverage effects (Bruskotter et al. 2007, Mertig 2004, Treves et al. 2009). Yet, some wildlife management actions remain highly controversial among stakeholder groups.

Social identity may cause stakeholders to organize into groups of individuals with similar positions, and identity differences between groups may be driving debate. Understanding group conflict through social identity theory may help inform human-wildlife conflict management and other politically contentious wildlife management issues.

Lute and Gore examined a case study of Michigan wolf management to determine if stewardship—defined as behavioral intentions motivated to benefit wolves or support their management—might help transcend different identities and reorient dialogue toward cooperation.

The authors found that in-group bias can reveal potential underlying factors for conflict over recovered wolf management—interviewees offered mostly negative and one-dimensional stereotypes of out-groups which dichotomized stakeholders into pro-hunting or anti-hunting across contexts. They suggest several methods for bringing stakeholders together including advancing group cooperation through activities aimed at addressing out-group stereotypes, encouraging diverse stakeholders to identify as stewards, and enfranchising groups to collaborate on shared responsibilities to nature.

Lute ML, Navarrete CD, Nelson MP, Gore ML. 2016. Moral Dimensions of Human-Wildlife Conflict. *Conservation Biology* 30(6):1200-11. DOI:10.1111/cobi.12731.

Despite increasing support for conservation globally, controversy over specific conservation policies persists among diverse stakeholders. Investigating the links between morals in relation to conservation can help increase understanding about why humans support or oppose policy, especially related to human–wildlife conflict or human conflict over wildlife. Yet the moral dimension of human–wildlife conflict has mostly gone unconsidered and unmeasured; thus, policy and programmatic efforts to reduce controversy may be missing a key part of the equation.

Lute et al. conducted a web-based survey in Michigan to investigate cognitive and emotional influences on the value–behavior relationship. Respondents were identified by their interest and involvement in Michigan wolf management. The survey consisted of questions about values, emotions, cognitions, and behaviors relative to wolves in Michigan. The authors used path analysis to explore whether emotions and cognitions mediated the relationship between value and behavior. Most respondents attributed intrinsic value to wolves and all life, and engaged in behaviors that benefited wolf populations and ecosystems regardless of stakeholder group (e.g., environmentalist, farmer).

Attributing intrinsic value to wolves was positively related to favorable emotions toward wolves and cognitive assessments that hunting and trapping of wolves is unacceptable. Despite similarities in attribution of intrinsic value, groups differed in emotions and cognitions about wolf hunting. The authors argue that these differences provide a useful way to predict stakeholder behavior, and that the findings may inform interventions aimed at increasing support for wolf management policies and positive interactions among stakeholders and wildlife. Leveraging agreement over intrinsic value may foster cooperation among stakeholders and garner support for controversial conservation policy.

Madden F. 2007. Creating Coexistence Between Humans and Wildlife: Global Perspectives on Local Efforts to Address Human-Wildlife Conflict. *Human Dimensions of Wildlife* 9:247-57. DOI:10.1080/10871200490505675.

As human populations and development expand, protected areas will increasingly become isolated islands of habitat. Ecosystem-based approaches (dispersal corridors, etc.) have clear value, but conservation efforts in this context hinge on effective integration of the human community. Without properly addressing human-wildlife conflict (HWC), conservation efforts will be hampered by instability and high costs (social and financial).

HWC is often really about human-human conflict, a fact that can hobble conservationists who fail to recognize it. Likewise, biological science does not provide a complete understanding of the conflict or of prospective solutions (precisely because it does not often account for the human dimension). Successful responses to HWC require multiple and adaptive tools, applied in a highly individual and contextual way.

To date, efforts to deal with HWC are chronically hampered by a lack of capacity, in terms of institutional procedures and principles, site-specific processes, policy, effective best-practices tools and approaches, etc. Madden suggests that conservation organizations should functionally recognize the complex, multidisciplinary nature of these conflicts. HWC mitigation efforts also benefit from the implementation of adaptive management and applied research schemes. As always, raw resources (human and financial) are requisite, and support resources need to be identified, developed, and strengthened in ways that attend to the complexity of HWC. In all efforts, collaboration and third-party facilitation are needed to ensure stakeholder engagement.

Madden argues that HWC escalates when people feel that the needs or values of wildlife are given priority over their own needs, and/or when local institutions and people are not adequately equipped to deal with the conflict. She suggests that establishment of equitable and effective management structures and mitigation processes is of great importance.

Madden F. 2008. The Growing Conflict Between Humans and Wildlife: Law and Policy as Contributing and Mitigating Factors. *Journal of International Wildlife Law and Policy* 11: 189-206. DOI: 10.1080/13880290802470281.

Human-wildlife conflict (HWC) is an increasingly significant obstacle to the conservation of wildlife. The growing body of HWC literature tends to focus on biological, economic and local aspects associated with HWC. The factors driving HWC at the local level are, however, shaped in turn by numerous other factors, including laws and policies. In many cases, legal and policy measures—particularly those involving land-use planning and wildlife management—contribute to this growing problem. Yet law and policy can play an important role in supporting the mitigation and prevention of HWC.

Madden identifies predicaments and challenges in current legal and policy strategies and suggests options for reforming law and policy to mitigate HWC. Specifically she reviews the natures and sources of HWC drawing on her own experience in the Bwindi Impenetrable Forest National Park in Uganda.

While more study is needed on HWC policy, Madden argues that preliminary conclusions can be drawn concerning avenues for improvement of relevant laws and policies. While the mix of circumstances of each HWC situation is unique, interesting commonalities are evident in the patterns of success and failure in HWC response, as well as commentators' recommendations for improvement.

Madden F, McQuinn, B. 2014. Conservation's Blind Spot: The Case for Conflict Transformation in Wildlife Conservation. *Biological Conservation* 178: 97-106. DOI: 10.1016/j.biocon.2014.07.015.

As the conservation field moves toward more collaborative governance models of engagement (Ansell and Gash 2008, Leong et al. 2011, Reid et al. 2009), too often the processes used or those who are

driving the process fail to recognize or reconcile deep-rooted conflict among stakeholders, which can result in hindered conservation goals. Without thorough analysis of these deeper social conflicts, stakeholder engagement processes often overlook or exacerbate the hidden dimensions of conflict that might, if addressed, create conditions for more sustainable long-term agreements.

Unmanaged or poorly managed conflict, including those between humans and wildlife, represents an increasingly difficult obstacle to effective management and conservation of many species of wildlife (Madde 2004, Michalski et al. 2006, Peterson et al. 2013, Redpath et al. 2013). Limited approaches fail to acknowledge, engage, and respond to the deeper social and psychological dynamics—the social conflicts—between individuals and groups.

Using two case studies—gray wolf recovery in Montana, Idaho, and Wyoming, and the fencing out of elephants in communities in south Africa—Madden and McQuinn illustrate how conservation setbacks often stem from a lack of consideration of the full conflict spectrum and an overemphasis on immediate material and economic factors.

Madden and McQuinn argue that long-term conservation success requires deepening conservationists' capacity and strategies to include responses that seek to understand and address these more elusive social conflicts. They propose a reorientation of conservation's understanding of and approaches for addressing conflict through conservation conflict transformation (CCT)—principles and processes adapted from the field of peacebuilding that strive to positively transform often unseen and destructive social conflicts that underlie many conservation efforts.

Maheshwari A, Midha N, Cherukupalli A. 2014. Participatory Rural Appraisal and Compensation Intervention: Challenges and Protocols While Managing Large Carnivore-Human Conflict. *Human Dimensions of Wildlife* 19(1): 62-71. DOI: 10.1080/10871209.2013.828247.

When large carnivores cause socioeconomic losses in a community, conflict increases, retaliatory killing of carnivores can occur, and conservation efforts are undermined (Cromsigt et al. 2013, Distefano 2005, Lee 2011, Loe and Röskft 2004, Madhusudan and Mishra 2003, Mishra 1997, Mishra et al. 2003, Ogra and Badola 2008. Patterson et al. 2004). Reducing antagonism-caused mortality is an important strategy for carnivore conservation (Lee 2011).

Participatory Rural Appraisal (PRA) is a common tool for measuring perceptions of local people on wildlife-human conflicts, but varied implementation approaches affect success and hinder the formulation of effective conflict resolution and conservation management (Bagchi and Mishra 2006, Cromsigt et al. 2013, Madhusudan and Mishra 2003).

Focusing on Participatory Rural Appraisal (PRA), Maheshwari et al. reviewed published papers and reports to share common pitfalls, key lessons learned, and possible solutions including new approaches for compensation and protocols to be followed while managing human-carnivore conflicts.

Mattson DJ, Byrd KL, Rutherford MB, Brown SR, Clark TW. 2006. Finding Common Ground in Large Carnivore Conservation: Mapping Contending Perspectives. *Environmental Science and Policy* 9:392-405. DOI:10.1016/j.envsci.2006.01.005.

Reducing conflict over large carnivore conservation requires understanding the values, beliefs, and demands of those who are involved. Large carnivores are potent symbols, and symbolic politics is central to many interactions about them. Unclear policy, uncertain information, and diverse and strongly felt demands have provided ample impetus for conflict among stakeholders. Competing definitions of the problem are often contradictory and are tightly linked with perceived solutions.

Mattson et al. conducted a workshop attended by diverse participants involved in large carnivore conservation in the northern US Rocky Mountains, and used Q methodology to elucidate participant perspectives regarding problems and solutions. The authors sorted and analyzed their participants' statements and orientations, dividing participants into a number of different groups—e.g. carnivore advocates and devolution advocates—corresponding to their overall stance and viewpoints.

Mattson et al. suggest themes for productive and ameliorative discussion among these otherwise divergent stakeholder groups; notably, all participants recognized (or tolerated) the need for respectful, persuasive, and creative processes that would build understanding and tolerance.

Mattson DJ, Logan K, Sweanor L. 2011. Factors Governing Risk of Cougar Attacks on Humans. *Human-Wildlife Interactions* 5(1):135-58.

Since the 1980s, wildlife managers have expressed increasing concern about the physical threat posed by cougars to humans. Reports document rising numbers of problematic encounters, especially during the 1990s and 2000s (Wakeling 2003, Barber 2005). Of perhaps greatest relevance is the numbers of confirmed attacks by cougars on humans; resulting human fatalities increased by 4- to 5-fold between the 1970s and 1990s (Sweanor and Logan 2010).

Using an analytic framework and multivariable logistic regression models to describe the risk of cougar-caused human injury or death, Mattson et al. analyzed 386 human-cougar encounters and determined that human and cougar behaviors and other factors surrounding cougar-human encounters are complex, and inferring causation can be challenging.

The authors provided a variety of correlations and relationships relating to cougar behavior and human actions, including fatality rates related to cougar age; use of firearms; presence of children and/or dogs; and aggressive human response to the cougar. They suggest that an important result of their investigations was to highlight the comparative rarity of deadly cougar attacks. Nonetheless, an awareness of what conditions and behaviors predispose for deadly encounters can be useful to wildlife managers.

Mattson DJ, Ruther EJ. 2012. Explaining Puma-Related Behaviors and Behavioral Intentions Among Northern Arizona Residents. *Human Dimensions of Wildlife* 17(2):91-111.

Puma management is characterized by stakeholder conflict fueled in part by peoples' responses to puma attacks and their perceptions of how puma predation affects huntable ungulates like deer and bighorn sheep. The policy process is typified by litigation, ballot initiatives, inflammatory incidents, and public incivility. Disagreements often focus on lethal management methods. Widespread trends toward biocentric or mutualist perspectives have changed and diversified people's demands regarding wildlife management outcomes, in stark contrast to historical demands based on utilitarian views, which shaped the cultures of most wildlife management agencies.

Mattson and Ruther assessed demographics, nature-views, puma-related experiences and behaviors, as well as support for various puma-related policies, among residents of Northern Arizona. Results clearly demonstrated that nature-views are superior to demographics in explaining (statistically and otherwise) the behaviors and perceptions of people who hold pronounced views on puma management. Of the variety of nature views that the authors describe, Utilitarian/Dominionistic (U/D) views seem to be the primary determinant of how people orient to pumas and puma policies. The strength of this U/D nature-view largely determines how people perceive lethal practices and policies. The U/D view was unambiguously and consistently identified with behaviors and policies that featured killing or opposition to policies that would limit killing. The U/D nature-view is very strongly related to support for lethal practices, which are the norm of current puma management.

Although hunting was strongly identified with U/D views, U/D views did not translate into support for protecting habitat to benefit pumas. Mattson and Ruther hypothesize that those with strong U/D views are inclined to see pumas as competitors for ungulate hunting opportunities, rather than as creatures of intrinsic value. The authors suggest that educating people about pumas will not have much effect on how they choose to behave when around pumas or what kinds of puma management they would support.

**McManus J, Smuts B. 2014. Dead or Alive? Comparing the Costs and Benefits of Lethal and Non-Lethal Human-Wildlife Conflict Mitigation on Livestock Farms. *Oryx* 49(4):687-95.
DOI:10.1017/S0030605313001610.**

Livestock depredation has implications for conservation and agronomy; it can be costly for farmers and can prompt retaliatory killing of carnivores. Lethal control measures are readily available and are reportedly perceived to be cheaper, more practical and more effective than non-lethal methods. However, the costs and efficacy of lethal vs non-lethal approaches have rarely been compared formally. McManus and Smuts conducted a 3-year study on 11 South African livestock farms, examining costs and benefits of lethal and non-lethal conflict mitigation methods. Farmers used existing lethal control in the first year and switched to guardian animals (dogs and alpacas) or livestock protection collars for the following 2 years, keeping track of mean costs of livestock per head and depredation. In the first year of non-lethal control the combined implementation and running costs were similar to those of lethal control. However, the mean cost of depredation decreased per head. In the second year of non-lethal control the running costs were significantly lower than in previous years and depredation costs decreased further.

The authors suggest that non-lethal methods of human–wildlife conflict mitigation can reduce depredation and can be economically advantageous compared to lethal methods of predator control.

Miller JRB. 2015. Mapping Attack Hotspots to Mitigate Human-Carnivore Conflict: Approaches and Applications of Spatial Predation Risk Modeling. *Biodivers Conserv* 24(12):2887-911. DOI:10.1007/s10531-015-0993-6.

Though cost-efficient nonlethal techniques exist for reducing carnivore attacks (McManus et al. 2014, Lichtenfeld et al. 2014), these tools are often time intensive and difficult to implement across the expansive landscapes where carnivores and livestock interact (Shivik 2006). As a result, many livestock owners continue to use lethal measures to reduce carnivore attacks (Ogada et al. 2003, Inskip et al. 2013), contributing to rapid carnivore population declines and loss of attendant ecosystem service values for humans (Ripple et al. 2014). However, a spatial statistical approach known as predation risk modeling that identifies high priority conflict hotspots where carnivores are likely to attack livestock is rapidly emerging as a tool for informing livestock management and carnivore conservation.

Miller evaluate the approaches and applications of spatial risk modeling for reducing human-carnivore conflict and presented a workflow to help conservation practitioners use this tool. She suggests a need for future predation risk modeling to focus more on validating models, accounting for feedbacks, and impacting conflict-related policy in order to reliably improve the mitigation of human-carnivore conflict globally.

Miller JRB, Jhala YV, Schmitz OJ. 2016. Human Perceptions Mirror Realities of Carnivore Attack Risk for Livestock: Implications for Mitigating Human-Carnivore Conflict. *PLoS ONE* 11(9). DOI:10.1371/journal.pone.0162685.

An important challenge in conserving large carnivores in human-dominated landscapes is overcoming human-wildlife conflict arising from people’s real or perceived threats to their livelihoods and personal safety (Ripple et al. 2014, Woodroffe et al. 2005). Methods used for reducing potential conflicts depend on people’s perceptions of predators, perceptions that are not always in parallel with carnivore behavior.

Miller et al. applied a landscape-scale spatial analysis of livestock killed by tigers and leopards in India to model and map observed attack risk, and surveyed owners of livestock killed by tigers and leopards for their ranking of threats across habitats in order to map perceived risks.

Miller et al. found that owners’ perceptions of threats largely did not depend on environmental conditions surrounding their village. Surveys revealed that the owners who previously lost livestock used more protection methods than those who had no prior losses, and owners who had recently lost livestock for the first time expressed greater interest in changing their methods than those who experienced prior losses.

The authors suggest that in systems where realities and perceptions of carnivore risk align, conservation programs and policies can optimize conservation outcomes.

Miller JRB, Stoner KJ, Cejtin MR, Meyer TK, Middleton AD, Schmitz OJ. 2016. Effectiveness of Contemporary Techniques for Reducing Livestock Depredations by Large Carnivores. *Wildlife Society Bulletin* 40(4):806-15. DOI:10.1002/wsb.720.

Mitigation of large carnivore depredation is essential to increasing stakeholder support for human–carnivore coexistence. Lethal and non-lethal techniques are implemented by managers, livestock producers, and other stakeholders to reduce livestock depredations by large carnivores. However, information regarding the relative effectiveness of techniques commonly used to reduce livestock depredations is currently lacking.

Miller et al. evaluated 66 published, peer-reviewed research papers that quantitatively measured livestock depredation before and after employing four categories of lethal and non-lethal mitigation techniques (livestock husbandry, predator deterrents and removal, and indirect management of land or wild prey) to assess their relative effectiveness as livestock protection strategies. Effectiveness of each technique was measured as the reported percent change in livestock losses. Husbandry and deterrents demonstrated the greatest potential but also the widest variability in effectiveness in reducing livestock losses. Removal of large carnivores never achieved 100% effectiveness but exhibited the lowest variation.

Although explicit measures of effectiveness were not reported for indirect management, livestock depredations commonly decreased with sparser and greater distances from vegetation cover, at greater distances from protected areas, and in areas with greater wild prey abundance. Information on time duration of effects was available only for deterrents; a tradeoff existed between the effectiveness of tools and the length of time a tool remained effective.

The authors' assessment revealed numerous sources of bias regarding the effectiveness of techniques as reported in the peer-reviewed literature, including a lack of replication across species and geographic regions, a focus on Canid carnivores in the United States, Europe, and Africa, and a publication bias toward studies reporting positive effects. Given these limitations, they encourage managers and conservationists to work with livestock producers to more consistently and quantitatively measure and report the impacts of mitigation techniques under a wider range of environmental, economic, and sociological conditions

Morehouse AT, Boyce MS. 2011. From Venison to Beef: Seasonal Changes in Wolf Diet Composition in a Livestock Grazing Landscape. *Frontiers in Ecology and the Environment* 9(8):440-45. DOI:10.1890/100172.

Wild ungulates are the primary prey for wolves in North America, but livestock predation is a concern in areas where wolves and livestock overlap. Using clusters of global positioning system telemetry relocations and scat analysis, Morehouse and Boyce investigated wolf diets year-round in southwestern Alberta, where seasonal cattle grazing is the predominant land use and wolf-cattle conflicts have increased in recent years.

Morehouse and Boyce found that data from kill-site visitation and scat analysis offered congruent results, indicating a seasonal shift in wolf diets from wild prey during the non-grazing season to cattle during in the grazing season.

The authors highlight that boneyards are a growing problem in SW Alberta, and have become more prevalent since the detection of bovine spongiform encephalopathy. Prior to this, rendering trucks often removed dead animals free of charge to be used in dog-food and cattle feed supplements. Government prohibitions have largely curtailed that practice.

The authors recommend development of alternative sanitary disposal methods for dead livestock, in order to prevent wolves from becoming accustomed to feeding on cattle. They suggest that this and other preventative measures will be important components of management plans aimed at reducing predation on cattle. This will be exceptionally critical in areas such as SW Alberta, where 3% of the Province's land area accounts for 37% of paid predator compensation claims. Localized efforts, targeted at these areas, will maximize cost-effectiveness.

Morehouse AT, Graves TA, Mickle N, Boyce MS. 2016. Nature vs. Nurture: Evidence for Social Learning of Conflict Behavior in Grizzly Bears. *PLoS One*. DOI:10.1371/journal.pone.0165425.

As grizzly bear populations expand their distribution from the high mountains after removal from much of their historic range (27 28 29), they increasingly overlap with human-settled lands where they are more likely to come into conflict with human land uses such as agriculture and ranching (30, 31, 32). Understanding how bears acquire conflict behavior can have important management implications, especially where conflicts limit public support.

Morehouse et al. evaluated evidence for social learning and genetic inheritance of conflict behavior in grizzly bears in southwestern Alberta, Canada. Using a parentage analysis, they tested the propensity for grizzly bear offspring to develop conflict behaviors as a result of learning between mothers and cubs, genetic inheritance, or both learning and inheritance.

The authors found that offspring of problem mothers were more likely to be involved in conflict behaviors, while offspring of non-problem mothers were not likely to be involved in incidents or human-bear conflicts. There was no evidence that offspring were more likely to be involved in conflict behavior if their fathers had been problem bears. They suggest that proactive mitigation to prevent female bears from becoming problem individuals likely will help prevent the perpetuation of conflicts through social learning.

Moss WE, Alldredge MW, Pauli JN. 2016. Quantifying Risk and Resource Use for a Large Carnivore in and Expanding Urban-Wildlife Interface. *Journal of Applied Ecology* 53:371-78. DOI:10.1111/1365-2664-12563.

Large carnivores, though globally threatened, are increasingly using developed landscapes. However, most of our knowledge of their ecology is derived from studies in wildland systems; thus, for effective conservation and management, there is a need to understand their behavioral plasticity and risk of mortality in more developed landscapes.

Moss et al. examined cougar foraging ecology and survival in an expanding urban-wildland system in Colorado from 2007 to 2013. For GPS-collared individuals, they related diet to age-sex class and fine-

scale space use, with regard to levels of habitat development. They also examined how habitat development impacted risk of mortality, using hazards models and records of cougar-human conflict.

The authors found that cougars obtained most of their assimilated biomass from native herbivores, and adult females consistently showed higher use of native herbivores than other age-sex classes. Individuals using the most highly developed areas obtained approximately 20% more of their diet from alternative prey (synanthropic wildlife and domestic species) than those in the least developed areas. Overall, survival of adult females was higher than adult males. Yet, use of developed areas substantially increased cougar risk of mortality.

Moss et al. found that cougars showed flexibility in diet, taking advantage of human associated prey items, but had high rates of mortality, suggesting that human tolerance, rather than adaptability, may be the limiting factor for range expansion by cougar and other large carnivores. They argue that large carnivore conservation will not only depend upon adequate prey resources, but also limiting potential conflict resulting from depredation of synanthropic wildlife and domestic animals.

Muhly TB, Dubois M. 2013. Advancing the Management of Carnivore Predation on Livestock in Western Canada. *Human Dimensions of Wildlife* 18(4):312-314. DOI:10.1080/10871209.2013.796540.

Currently, financial compensation for livestock losses and lethal control of carnivores are the most common tools for addressing livestock predation by carnivores in western Canada (Musiani and Paquet 2004, Treves and Naughton-Treves 2005). However, there is decreasing acceptance by the general public for lethal control (Kellert et al. 1996, Treves and Naughton-Treves 2005), and compensation programs have generally proven to be ineffective at reducing long-term conflict because they fail to prevent future predation (Boitani et al. 2010) or address social factors related to livestock predation conflict (Dickman 2010, Naughton-Treves et al. 2003).

Muhly and Dubois collected from government management agencies and livestock production organizations perceptions of the importance and effectiveness of, and suggested improvements to, management of livestock predation by carnivores in western Canada.

Livestock predation ranked as a top-five priority issue for all those interviewed, and included associated issues related to stable funding and staff; greater agency participation; interest in group engagement; and need for better data. Muhly and Dubois found that compensation programs and lethal control of carnivores are both generally considered ineffective and controversial at reducing conflict. Conversely, subsidizing tools that proactively prevent predation were found to increase positive attitudes toward carnivores (Karlsson and Sjostrom 2011). Increased funding and public/stakeholder engagement strategies such as Adaptive co-management were recommended.

Muhly, TB., Musiani, M. 2009. Livestock Depredation by Wolves and the Ranching Economy in the Northwestern U.S. *Ecological Economics* 68: 2439-50. DOI:10.1016/j.ecolecon.2009.04.008.

Because of depredation of livestock by wolves, some groups and individuals oppose wolf conservation in the Northwestern United States. Depredation can have significant monetary costs and cause emotional

stress for individual livestock producers, which creates conflict between producers, wolves, and organizations involved in wolf conservation and management.

Compensation is the main tool used to mitigate the costs of depredation; however, this tool does not generally increase tolerance for wolves. Livestock production may in fact indirectly provide an important benefit for wolf conservation by maintaining relatively intact habitat on private lands.

Muhly and Musiani investigated patterns and trends in livestock depredation by wolves, compensation for depredation, and livestock and land price in Idaho, Montana, and Wyoming from 1987 to 2003. They analyzed some of the costs of livestock depredation by wolves relative to recent economic trends in the livestock production industry; specifically income generated from livestock production and trends in land and livestock value.

The authors found that instigation of attacks on livestock by wolves was determined by need for food, but wolves may kill sheep in excess of food needs, which may contribute significantly to intolerance for wolves. Muhly and Musiani report that livestock killed by wolves cost producers approximately \$11,076.49 per year between 1987 and 200 and each year these costs accounted for less than 0.01% of the annual gross income from livestock operations. They conclude that wolf depredation is a relatively small economic cost to the industry, although it may be a significant cost to affected producers, as these costs are not equitably distributed across the industry.

Muhly and Musiani suggest that conservation groups should consider the potential consequences of all of these economic trends. Declining cattle prices and the steady increase in land price might prompt conversion of agricultural land onto residential developments, which could negatively impact wolf conservation through large-scale habitat change and increased human presence.

Musiani M, Mamo C, Biotani L, Callaghan C, Gates CC, Mattei L, Visalberghi E, Breck S, Volpi G. 2003. Wolf Depredation Trends and the Use of Fladry Barriers to Protect Livestock in Western North America. *Conservation Biology* 17(6):1538-47.

There are limited cost-effective nonlethal techniques available for managing predation risk from wolves. Many of these tools can be expensive, difficult to maintain, or provide only temporary relief from depredation. Musiani et al. tested the effectiveness of fladry barriers in a number of settings, observing captive and wild wolves in conjunction with bait as well as ranging cattle. They observed that fladry barriers prevented captive wolves from accessing food for up to 28 hours; that wolves approached fladry barriers on 23 occasions but did not cross them; and that no cattle were killed. Wolves killed cattle on neighboring ranches during the trials and before and after the trials on the tested ranches.

Although wolves tended to avoid fladry, they continued to investigate the barrier throughout observed trials, presumably testing the structure for opportunities to cross. The authors could not isolate fear of novelty/habituation as a factor in their study, and did not rule out that their presence monitoring the fladry barriers may have exerted an effect on some of the trials.

Musiani et al. speculate that presence of available prey outside a fladry boundary is critical for enhancing its effectiveness. Also, that fladry may be much less effective when applied on large properties and/or on several contiguous pastures. They suggest that fladry may be most effective to temporarily protect livestock from wolves when livestock is kept in small pastures, such as is done for

calving, lambing, overnight holding, or rotational grazing. The authors suggest that fladry can indeed be a very effective tool for deterring wolves in this context. It is simply important to know when and where it will be most effective, as opposed to an alternative option.

Musiani M, Muhly T, Gates CC, Callaghan C, Smith ME, Tosoni E. 2005. Seasonality and Reoccurrence of Depredation and Wolf Control in Western North America. *Wildlife Society Bulletin* 33(30):876-87.

Wolf depredation and control follow a reoccurring seasonal-annual pattern in Alberta and the northwestern U.S. These patterns reflect husbandry practices including the seasonality of livestock calving and grazing practices, as well as seasonal variation in the energetic requirements of wolf packs.

Musiani et al. gathered data from wolf depredation investigations in Alberta, Idaho, Montana, and Wyoming from 1987 to 2003. They analyzed temporal trends in wolf depredation occurrence and wolf control employed as a management action.

Seasonal wolf attacks on livestock were auto-correlated with lags of one year, indicating annual re-occurrence. Cross-correlation analyses indicated that limited wolf control was rapidly employed as a short-term response to depredation, but did not seem to decrease wolf depredation at regional scales or in the long-term.

The authors suggest that ranchers and managers focus their investment of resources on preventative tools during high-depredation seasons and/or locations. Likewise, they advocate for a better understanding of factors predispose for depredation (and subsequent wolf control actions), to allow better anticipation of problems and efficient targeting of conflict management resources.

Naughton-Treves L, Grossberg R, Treves A. 2003. Paying for tolerance: Rural Citizens' Attitudes Toward Wolf Depredation and Compensation. *Conservation Biology* 17(6):1500-11.

As wolf populations recover in Wisconsin, their depredations on livestock, pets, and hunting dogs have increased. Naughton-Treves et al. used a mail-back survey to assess rural Wisconsin citizens' tolerance for wolves, as well as their preferences for managing problem wolves. They assessed tolerance via proxy factors related to preferred wolf population size, likelihood that a person would shoot a wolf, etc. Individuals' approval of lethal control and other management tactics were gauged using five hypothetical conflict scenarios.

The authors found moderate support for wolf recovery in Wisconsin, although 85% percent of respondents wanted a cap placed on the state's population. There were mixed reactions to lethal control, although respondents exhibited fairly strong acceptance of lethal methods.

Not surprisingly, multivariate analysis revealed that the strongest predictor of tolerance was social group. This was more significant than personal exposure or experience with wolves. To a lesser degree, education level, experience of loss (livestock, pets) to wolves, and gender were also significant. Stockmen and hunters who had received compensation for their losses to wolves were *not* more tolerant than their counterparts who alleged a loss but received no compensation, yet all respondents

approved of compensation payments as a management strategy. The authors suggest that deep-rooted social identity and occupation are much more powerful predictors of wolf tolerance than direct individual experience with them.

Nelson AA, Kauffman MJ, Middleton AD, Jimenez MD, McWhirter DE, Barber J, Gerow K. 2012. Elk Migration Patterns and Human Activity Influence Wolf Habitat Use in the Greater Yellowstone Ecosystem. *Ecological Applications* 22(8):2293–307. DOI:10.1890/11-1829.1.

Nelson et al. evaluated the influence of elk distribution on wolf habitat use in an area of chronic wolf-livestock conflict in the Greater Yellowstone Ecosystem. Using three years of fine-scale wolf and elk movement data, they compared the seasonal habitat use of wolves in an area dominated by migratory elk with that of wolves in an adjacent area dominated by resident elk.

Although wolves in both areas used elk-rich habitat all year, elk density in summer had a weaker influence on the habitat use of wolves in the migratory elk area than the resident elk area. In the summer, wolves in both prey areas showed use of low-elevation habitats, probably because they only occasionally used high-elevation habitat with elk, but spent more time at moderate elevations close to their home sites. In winter, wolves in the migratory elk area used habitat close to roads, while wolves in the resident elk area avoided roads. In summer, wolves in the migratory elk area were indifferent to roads, while wolves in resident elk areas strongly avoided roads, presumably due to the location of dens and summering elk combined with different traffic levels.

Unexpectedly, the difference in influence of elk on wolf habitat use between summer and winter was much greater among wolves in the resident elk area than the migratory elk area. Extraterritorial forays and rendezvous site shifts seem to allow wolves to track migrating elk relatively well, largely explaining the unexpectedly consistent use of prey-rich habitat.

The results imply that wolves frequent human-dominated areas to a greater degree when high prey density provides a strong incentive; and, where prey exist close to humans, wolves reduce their risk of human-caused mortality by increasing their nocturnal behavior. Even in the face of high rates of lethal removal, wolves will continue to be attracted to—and even intermittently productive within—these front-country landscapes with abundant resident elk populations.

Nelson AA, Kauffman MJ, Middleton AD, Jimenez MD, McWhirter DE, Gerow K. 2016. Native Prey Distribution and Migration Mediates Wolf (*Canis lupus*) Predation on Domestic Livestock in Greater Yellowstone Ecosystem. *Canadian Journal of Zoology* 94(4):291-99. DOI:10.1139/cjz-2015-0094.

Little research has evaluated how the migration and distribution of native prey influence patterns of livestock depredation by large carnivores. Previous research suggests that the presence of native prey can increase depredation rates by attracting predators (prey tracking hypothesis). Alternatively, the absence of native prey may facilitate predation on livestock (prey scarcity hypothesis).

Nelson et al. evaluated support for these competing hypotheses through analysis of 4 years of cattle depredation data, 2 years of summer and fall wolf predation and tracking data, and 3 years of elk

movement data. The authors compared the relative influence of landscape features and elk distribution on the risk of livestock depredation in areas with migratory and resident elk.

The authors found that cattle depredations occurred in habitats with increased encounter rates between wolves and livestock. In resident elk areas, depredation sites were associated with elk distribution and open roads. In migratory elk areas, depredation sites were associated with wolf dens, streams, and open habitat. Nelson et al. argue that patterns of carnivore–livestock conflicts are complex, and using ungulate distribution data can predict and minimize such instances.

Nie MA. 2001. The Sociopolitical Dimensions of Wolf Management and Restoration in the United States. *Research in Human Ecology* 8(1):1-12.

Those immersed in wolf politics and policy will recognize that orderly techno-rational and scientific approaches are usually overly simplistic precisely because they don't really attend to issues such as: community and conceptions of public interest; culture and socialization; myths and images; how information is interpreted, imperfect, framed, and strategically manipulated; and how the essence of policymaking is the struggle over ideas, rather than over concrete, quantifiable, or non-subjective things. Many scientific discussions dismiss these factors as hindrances to good management, rather than acknowledging their centrality to the process.

How a policy issue is framed and how problems are defined is critical because they tend to color the way we think, talk about, and approach a policy issue. This can implicitly favor some values, players, and solutions over others. Multiple competing definitions of the wolf problem (i.e., wolves and the need for wilderness; wolves and the need for ecological restoration; wolves as federal Trojan horse; wolves and urban subjugation of rural values; etc.) have serious implications for any management approach.

Nie examines the political-cultural and sociological context of wolf management in the U.S. He argues that wolf politics and policy are about much more than wolves and their management. Carnivore conservation is often surrogate for broader cultural conflicts: preservation versus use of resources; recreation-based economies versus extraction-dependent economies; urban versus rural values; states' rights versus federalism; etc.

Deciding how decisions should be made—from the proper balance of scientists and stakeholders to who should be invited to the decision-making table—is often central. Overall, Nie argues that successful efforts will depend on how well professionals understand and attend to this sociopolitical context, as well as the questions and challenges that it raises.

Nie MA. 2002. Wolf Recovery and Management as Value-Based Political Conflict. *Ethics, Place and Environment* 5(1):65-71.

Conflict over wolf management might be best understood as value-based political conflict, occurring over a deeply symbolic animal in a very controversial political and cultural context—one that transcends issues strictly pertaining to science, biology, and technical problem-solving. However it is not just a question of what values are involved in the wolf debate, but where these values are located and what

power they wield in the decision-making process. For instance, some groups argue that there is a serious divide between the institutional values of state fish and game departments and those of the public at large.

Competing ideas of the public interest are at the heart of wolf policy. The proper role of science is a recurring theme. Science can help answer a question such as how much livestock predation can be expected from a wolf population in a national forest area, but it cannot answer normative questions such as whether wolves or cows should be in that national forest area. This is a distinction that is often ignored in management debates.

Nie argues that political and cultural context will continue to shape the future of the wolf, and, as such, place matters. The political and cultural landscapes in which wolves are making their return are as varied as their physical environments. In the Northern Rockies, for instance, the situation is characterized by public land and public land agencies; it is a story of bureaucratic politics, environmentalists, and ranchers.

Nie suggests that those engaged in the debate should acknowledge its value-based character. It is important for the wolf decision-making process to be as inclusive, participatory, and representative as possible. The process must offer more access and accountability. Multiple stakeholders with multiple values must be given a larger role. Ultimately, Nie argues, a well-structured stakeholder framework can offer a more constructive way of dealing with value-based political conflict and the sociopolitical dimensions of wolf-recovery.

Nie MA. 2004. State Wildlife Policy and Management: The Scope and Bias of Political Conflict. *Public Administration Review* 64(2):221-33.

State wildlife management is often characterized by divisive political conflict. Policy and management decisions are often made by state wildlife commissions, boards, or councils, and are perceived by some as biased, exclusive, or unrepresentative of non-consumptive stakeholder values, which has led to many groups now using ballot initiatives to influence wildlife policy and management decisions.

There are important ramifications associated with management by ballot initiative—ramifications of concern to many wildlife professionals. Adversarial and dichotomous (yes/no, for/against) policy making inhibits deliberation, meaningful dialogue, and compromise. Quality and stability of public opinion concerning wildlife-related issues is up for debate. Science, biology, and professional wildlife management may or may not be able to play a real role in the process. Special interest groups and money wield great power under such a scheme. Tyranny of the majority situations are also possible (less numerous rural citizens are often disproportionately affected by wildlife decisions).

Nie discusses the history of state wildlife management agencies, as well as the management structures and paradigms that have historically characterized them, and explores several alternative options for state wildlife policy-making and management.

New voices are likely to play a more important role in wildlife policy making and management. It is worth asking whether this expanding scope will simply lead to increased gridlock. Ballot initiative and collaborative conservation both have their strengths and weaknesses, but they have at least one thing in

common—both expand the scope and bias of wildlife-centered political conflict. Nie argues that all prospective methods for developing policy deserve careful examination, particularly how they might enhance effectiveness, accountability, and/or promote democratic values that safeguard the public interest in wildlife.

Northrup J, Stenhouse G, Boyce M. 2012. Agricultural Lands as Ecological Traps for Grizzly Bears. *Animal Conservation* 15:369–77. DOI:10.1111/j.1469-1795.2012.00525.x.

Human-carnivore conflicts on agricultural lands are a global conservation issue affecting carnivore population viability, as well as human safety and livelihoods. Locations of conflicts are influenced by both human presence and carnivore habitat selection, although these two aspects of conflict rarely have been examined concurrently. Understanding patterns of conflict (where and why they occur) and finding ways to reduce conflict are important in large carnivore conservation.

Northrup et al. reviewed 10 years of data on conflicts between grizzly bears and humans in southwestern Alberta, Canada, using logistic regression models in a geographic information system to map the probability of bear-human conflict from these data, and the relative probability of grizzly bear habitat selection based on global positioning system radio-telemetry data. They overlaid these maps to identify ecological traps, as well as areas of secure habitat.

Northrup et al. found that patterns of bear-human conflict in the study area resulted from overlap between human developments and highly selected habitats. These areas of overlap were almost exclusively on private lands, and the probability of bear-human conflict was higher in areas adjacent to quarter sections in which there had been a conflict, indicating a non-random distribution of risk areas. The majority of the habitats highly selected by grizzly bears directly coincided with areas of high conflict risk. Private agricultural lands contained almost the entirety of habitats selected by bears, and more than 50% of these lands were classified as ecological traps at night when the bears were most active. Northrup et al. found that bears in the area have little secure habitat.

The authors conclude that small steps, such as reducing bear attractants is necessary, yet this is not enough when conflicts ultimately are a result of humans living and working in prime bear habitats. They suggest, to ensure self-sustaining populations of large carnivores in southwestern Alberta, humans must be willing to coexist, which will require management agencies and conservation groups to work directly with agricultural stakeholders.

Nyhus PJ. 2016. Human-Wildlife Conflict and Coexistence. *Annual Review of Environment and Resources* 41:143-71. DOI:10.1146/annurev-environ-110615-085634.

Human interactions with wildlife—positive or negative—are a defining experience of human existence. People compete with wildlife for food and resources, and have eradicated dangerous species; co-opted and domesticated valuable species; and applied a wide range of social, behavioral, and technical approaches to reduce negative interactions with wildlife. This conflict has led to the extinction and reduction of numerous species and uncountable human deaths and economic losses.

Recent advances in our understanding of conflict have led to a growing number of positive conservation and coexistence outcomes. Nyhus summarizes and synthesizes factors that contribute to conflict, approaches that mitigate conflict and encourage coexistence, and emerging trends and debates. Fertile areas for scholarship include scale and complexity; models and scenarios; understanding generalizable patterns; expanding boundaries of what is considered conflict; using new tools and technologies; information sharing and collaboration; and the implications of global change.

Nyhus suggests that the time may be ripe to identify a new field—anthrotherology—that brings together scholars and practitioners from different disciplinary perspectives to address human–wildlife conflict and coexistence.

Ogada MO. 2015. HWC 2003 + 10 Years: Carnivore-Livestock Conflicts, Tourism, Donors, Compensation: What about the Human Dimensions? *Human Dimensions of Wildlife* 20(4): 329-32. DOI: 10.1080/10871209.2015.1007180.

Over the last 10 years, significant strides have been made in understanding the technical aspects of human–wildlife conflict mitigation, but the human dimensions aspect still lags far behind. In Kenya, this skewed understanding has resulted in the application of technical solutions to human problems. The reason for this is the tendency of conservationists to take an “ecological” approach to addressing challenges facing African communities living with wildlife. The sociocultural and economic values around livestock do not feature in the thinking of those addressing livestock depredation, yet it is known that the technical and ecological aspects alone are not sufficient.

Ogada argues that the greatest failing of conservation practitioners and scientists in Kenya is the failure to make local communities intellectual participants in this practice. This in turn, is the reason why they have been unable to impress upon Kenyans the responsibilities of conservation, which is evident in the way they view conservation as a short route to profit, rather than a principle to live by in the long term.

Wildlife conservation is a long-term goal, and has to be pursued using sustainable means. Ogada suggests that the establishment of community conservation areas and community owned eco-lodges has gone some way toward achieving this aim. These facilities have created employment and new livelihoods for members of these communities, but these have been limited. There needs to be a more thorough exploration of existing livelihoods, and how they can be enhanced to bring maximum returns to these communities.

Overall, conservation science must be as dynamic as the systems it seeks to conserve. It is a perpetual pursuit and the scientists involved need to appreciate this. There is a very strong tendency to create, highlight, and maintain crises to attract more funding, publications, fame, and even more funding. Often, this leads scientists to completely ignore the human dimensions and human problems that are the core challenge to conservation. This in turn, leads to a backlash against the wildlife we seek to conserve. This is bound to happen to predators in areas of Kenya where compensation is not offered. Livestock depredation is just a part of a larger “circle” of socioeconomic and environmental challenges. It is imperative that conservation biologists and practitioners recognize it as such before we try and mitigate it, or we are bound to fail.

A coherent, indigenous research agenda in the Kenya Wildlife Service will go a long way toward addressing this lacuna. Ogada argues that practitioners should dedicate the next decade to understanding that Africa's people are not just part of the landscape but are also custodians of wildlife.

Olson ER, Stenglein JL, Shelley V, Rissman AR, Browne-Nunez C, Voyles Z, Wydeven AP, Van Deelen T. 2014. Pendulum Swings in Wolf Management Led to Conflict, Illegal Kills, and a Legislated Wolf Hunt. *Conservation Letters* 8(5): 1-10. DOI:10.1111/conl.12141.

Conflict over wildlife can occur when wildlife management actions are incompatible with the values of some stakeholders (Zinn et al. 1998; Shelley et al. 2011). Sociopolitical forces can reinforce conflict and trigger intractable debates, such as conflict over gray wolf management (Messmer et al. 2001; Nie 2002, 2003; Gray 2004). Interests of empowered stakeholders can determine wildlife policy (Rinfret 2011), leading to management that may be inconsistent with broader public support.

Sociopolitical conflict over wildlife can be visualized as a pendulum swinging between exploitative and protective management as different stakeholder groups gain political power, producing inconsistency in wildlife management (Messmer et al. 2001). Yet, while debates occur in public meetings, board rooms, and within the legal system, the effects of sociopolitical conflict unfold on the ground between people and wildlife (Nie 2003).

Through an interdisciplinary approach, Olson et al. explored the complex dynamics of wolf management options, public attitudes, and illegal killing of wolves in Wisconsin during a period of intense sociopolitical conflict (2003–2011). They found that swings in wolf status led to inconsistent management authority, declining local public support for wolves, and possibly the unintended backlash of more illegal kills and a legislatively mandated public wolf hunt.

The authors argue that moderating the sociopolitical drives of swings in policy over short periods is essential to allow wildlife managers greater flexibility in achieving species-specific goals. They recommend that states avoid prescriptive harvest legislation and suggest a more incremental shift from federal to state management authority.

Ordiz A, Bischof R, Swenson JE. 2013. Saving Large Carnivores, but Losing the Apex Predator? *Biological Conservation* 168: 128-33. DOI: 10.1016/j.biocon.2013.09.024.

The widespread decline in numbers and distribution of large carnivores due to human persecution has led to a loss and reconfiguration of biological diversity in many ecosystems, highlighting the ecological effect of the carnivores and the broad-scale consequences of their loss (Terborgh et al. 2001, Ray et al. 2005, Terborgh and Estes 2010, Estes et al. 2011).

Carnivores are frequently used as flagship species whose conservation benefits can extend to entire communities (Sergio et al. 2008). Nevertheless, conservation of large carnivores remains controversial, forcing managers to make compromises. Hunting of large carnivores occurs worldwide and is sometimes used as a management tool to support carnivore conservation (Treves and Karanth 2003, Linnell et al.

2007, Treves 2009). However, killing carnivores can disrupt their social organization, affecting both carnivore population dynamics and management goals.

Ordiz et al. found that while hunting may directly or indirectly separate carnivores from humans and their property, which is important for conflict avoidance (Treves and Karanth 2003), the complex behavioral ecology of large carnivores, their ecosystem-wide effects, and the ramifications of human exploitation lead them to question whether carnivores subjected to exploitation and pre-emptive control can effectively fulfill their ecological role. They suggest five recommendations for large carnivore managers to consider.

Parker ID, Feldpausch-Parker AM. 2013. Yellowstone Grizzly Delisting Rhetoric: An Analysis of the Online Debate. *Wildlife Society Bulletin* 37(2): 248-55. DOI: 10.1002/wsb.251.

The Yellowstone grizzly bear delisting debate illustrates how rhetoric can contribute to fragmentation and polarization among stakeholders engaged in endangered species conflicts. The partisan view of the grizzly ideograph, and what it represented, created impediments to conflict management (e.g. mistrust and development of and/or belief in stereotypes. The debate coalesced as the U.S. Fish and Wildlife Service began proceedings to delist the Yellowstone population from the endangered list in 2005.

Parker and Feldspausch-Parker used a rhetorical analysis of the internet-based debate to identify strategies used by disputants in conflicts over the Endangered Species Act. By analyzing web-based stakeholder texts from 1998 through 2009, they found that rhetoric about grizzly bears fell into three main categories of rhetoric appeal: authority, ethics, and identity.

Parker and Feldspausch-Parker found that arguments relying on these appeals contributed to destructive communication about stakeholders. They also found that perspectives toward climate change influenced perception of grizzly delisting. They demonstrated how rhetorical analyses can reveal disputants' preferred social control frameworks, which they suggest can be important information for managers seeking to promote common ground between otherwise conflicted stakeholders.

Peebles KA, Wielgus RB, Maletzke BT, Swanson ME. 2013. Effects of Remedial Sport Hunting on Cougar Complaints and Livestock Depredation. *PLoS ONE* 8(11):e79713. DOI:10.1371/journal.pone.0079713.

Sport hunting is often used as a preventative or remedial measure to reduce carnivores and related human complaints and/or livestock depredations for many predators. However, the assumption that increased sport hunting reduces complaints and depredations did not appear to have been scientifically tested.

Using cougars as their study animal, Peebles et al. collected data on numbers of complaints, livestock depredations, cougars harvested, estimated cougar populations, and human and livestock populations for all 39 counties and 136 game management units in the state of Washington from 2005 through 2010.

As expected, they found that complaints and depredations were positively associated with human, livestock, and cougar populations. However, Peebles et al. found that remedial sport hunting to reduce complaints and depredations actually appeared to be associated with increased, not decreased, complaints and depredations the following year.

Piedallu B, Quenette P-Y, Mounet C, Lescureux N, Borelli-Massines M, Dubarry E, Camarra J-J, Gimenez O. 2016. Spatial Variation in Public Attitudes Towards Brown Bears in the French Pyrenees. *Biological Conservation* 197:90-97. DOI:10.1016/j.biocon.2016.02.027.

Local attitudes toward wildlife populations are typically investigated using sociocultural parameters, such as gender (Bath et al. 2008, Gore and Kahler 2012), age (Majić and Bath 2010), scientific knowledge of the species' ecology (Kaczensky et al. 2004, Thornton and Quinn 2009, Glikman et al. 2012), participation in activities related to wildlife (Bath et al. 2008, Majić et al. 2011, Gangaas et al. 2013), and involvement in farming/ranching (Kaczensky et al. 2004, Sponarski et al. 2013).

However, the geographic location of the residence is rarely considered, except at very large spatial scales such as entire regions (Kaczensky et al. 2004, Majić and Bath 2010) or countries (Gangaas et al. 2013). Smaller-scale spatial variations in attitudes within rural areas remain largely unexplored (Sponarski et al. 2013) despite their potential to improve our understanding of the sociological component of human-wildlife conflict.

Piedallu et al. investigated the often neglected spatial variations in attitude toward predator presence to improve understanding of the human dimensions surrounding this conflict. They used a questionnaire to assess the drivers explaining the attitude of the local human population of the Pyrenees toward bear presence. Results showed that spatial variables (place of birth and county of residence of the respondent) are strong predictors of attitude. The residents of two counties in particular (Haute-Garonne and Pyrénées-Atlantiques) displayed a positive attitude, while the residents of the Hautes-Pyrénées county had the most negative attitude. People born outside of the Pyrenees also showed a more positive inclination toward bear presence than people born and raised in France's southwestern mountain range.

The authors suggest that both these results may imply a link between the history of local communities with predator presence and their current attitude. Accounting for small-scale spatial heterogeneity in socioecological studies of human-wildlife conflicts will prove useful to get a more accurate mapping of attitudes and inform subsequent management decisions.

Potgieter GC, Kerley GI, Marker LL. 2016. More Bark than Bite? The Role of Livestock Guarding Dogs in Predator Control on Namibian Farmlands. *Oryx* 50(3):514-22. DOI:10.1017/S0030605315000113.

Human-carnivore conflicts occur most commonly when carnivores prey on domesticated livestock, and farmers respond by killing carnivores (Siller-Zubiri and Laurenson 2001, Woodroffe et al. 2005). Mitigating farmer-carnivore conflict is thus a key component of carnivore, and hence biodiversity, conservation (Treves and Karanth 2003, Breitenmoser et al. 2005). Although conflict mitigation ultimately relies on addressing the competing human interests of livestock farming and carnivore

conservation (Madden and McQuinn 2014, Redpath et al. 2015), efforts by conservationists to reduce actual and perceived livestock losses by farmers play a key role in improving relationships between these stakeholders.

Livestock guarding dogs are promoted as a non-lethal, environmentally friendly method to mitigate these conflicts. As part of a farmer–carnivore conflict mitigation program, the Cheetah Conservation Fund breeds Anatolian shepherd (also known as Kangal) dogs to protect livestock from predators. During 2009–2010, Potgieter interviewed commercial and subsistence Namibian farmers who were using guarding dogs. Fewer commercial and subsistence farmers reported livestock losses to predators during the most recent year of guarding-dog use compared to the year before dogs were introduced. All subsistence farmers, but not all commercial farmers, ceased killing predators during the most recent year of guarding-dog use. All farmers ceased killing cheetah and leopard during this year, and one dog killed a single cheetah.

Conversely, dogs and farmers killed more black-backed jackals between them in the survey year than the farmers reported killing in the year before acquiring dogs. Two of the dogs reportedly killed non-target carnivore species, and 15 killed prey species. Thus the authors' results challenge the categorization of livestock guarding dogs as a non-lethal conflict mitigation method. They suggest that the conservation status and body size of wild carnivores relative to the size of the guarding dogs be considered before introducing dogs to protect livestock. Additionally, corrective training for dogs that chase or kill non-target species should be implemented, especially where farmers value these species or where non-target species are threatened.

Primm SA, Clark TW. 1996. Making Sense of the Policy Process for Carnivore Conservation.
Conservation Biology 10(4):1036-45.

Carnivore conservation extends beyond biological issues, yet there is a marked tendency among scientists and other people to dismiss major aspects of the policy process as mere politics. This implies that there are two separate, parallel arenas for authoritative decision-making: one rational (science) and one irrational (politics). To dismiss nonscientific aspects of large carnivore conservation as politics undermines a useful understanding of the conservation process.

The biggest constraint on large carnivore conservation is extensive habitat requirements. Another major constraint is a dearth of resources and means for effective conservation. Carnivore conservation is also often surrogate for broader cultural conflicts: preservation versus use; recreation-based versus extraction-dependent economies; urban versus rural values; and states' rights versus federalism. In addition, carnivore management is heavily influenced by a wide range of other policies. County zoning regulations, public lands grazing, and federal budgetary politics all have effects, even though they are not formally part of predator policy.

Primm and Clark argue that scientists must understand the range of participants in the policy process. This will help scientists better understand their role in framing and clarifying policy questions, projecting the consequences of various alternatives, and presenting policy information. Those committed to large carnivore conservation must be problem-solvers in social contexts and in real-life situations.

Primm and Clark suggest that improving public debate and moving toward a stable reduction in cultural conflict will require processes that bring citizens and diverse experts together to work toward common goals and to resolve policy disputes. The authors see a need to improve our methods for making collective decisions and solving public problems. Field-testing innovative strategies will require a critical mass of committed, policy-oriented individuals from a wide range of organizations and disciplines. These people should be willing to inquire into the nature of broad-scale social contexts, and seek problem-solving opportunities at smaller scales that develop and apply integrated and adaptive policies.

Primm SA, Wilson SM. 2004. Reconnecting Grizzly Bear Populations: Prospects for Participatory Projects. *Ursus* 15(1):104-14.

Grizzly bear populations will generally benefit from linkage habitat that connects them with other subpopulations. Much discussion of linkage habitat focuses on ecological information, but Primm and Wilson argue that we should not overlook the cultural and political dimensions of these landscapes.

People living with recovering and expanding populations have valuable insight and practical knowledge that should inform management and conservation programs. This requires a systematic approach to understanding social context and involving people in research and planning. It will provide good prospects for designing innovative programs adapted to local situations. The authors argue that small-scale participatory projects can be models for subsequent conservation projects, as well as building political support by demonstrating success.

Primm and Wilson outline several foundational elements for conserving linkage habitat: sequential projects beginning in occupied habitat, project areas scaled/matched to human communities, effective and extensive social context mapping, and integration of projects with existing efforts. They authors also outline a framework for effective and equitable participatory conservation, and point out that participatory problem solving should not be all talk; these processes can and should focus on tangible outcomes. Burnout is high among volunteers and stakeholders if they feel no sense of progress or accomplishment.

Dialogue separate from authoritative decision-making is a key element, because it addresses the value conflicts that underlie disputes over conservation. The authors reiterate that action and dialogue should be interwoven. It is also important for practitioners to have clear objectives and communicate with one another to coordinate and share lessons. Finally, they suggest that small-scale projects can serve as models for leveraging larger conservation efforts.

Proctor MF, Nielsen SE, Kasworm WF, Servheen C, Radandt TG, Machutchon AG, Boyce MS. 2015. Grizzly Bear Connectivity Mapping in the Canada-United States Trans-Border Region. *Journal of Wildlife Management* 79(4): 544-588. DOI: 10.1002/jwmg.862.

Fragmentation of large carnivore populations at the southern extent of their North American distributions has led to increased attention on issues of connectivity. Specifically, there is growing interest in identifying numerous methods for identifying wildlife corridors or linkage areas to reverse fragmentation of habitat and population.

Human-caused mortality associated with settlement along highways is a primary mechanism of population fragmentation in the Canada-United States trans-border region (Proctor et al. 2012).

For grizzly bears in particular, extensive population fragmentation exists throughout the Canada-US trans-border region of southern British Columbia and Alberta, and northern Montana, Idaho, and Washington. Small, subpopulations with minimal or no female interchange are separated by human presence and highways. Long-term survival depends on reconnecting them with larger regional subpopulations.

Proctor et al. (2012, 2016) recommend management actions to increase linkage areas between regional subpopulations to enhance survival and demographic exchange, using a predictive method for identifying linkage areas (resource selection function models based on grizzly GPS) in regions where bears are crossing highways as well as in regions where they are not. While crossing structures can be important tools to reduce highway mortalities and enhance wildlife connectivity, Proctor et al. (2012) found human settlements to be the most important fracturing force for grizzly bears regionally. This pattern suggests that management strategies that reduce grizzly bear mortality from human conflict and minimize human densities in linkage areas may help increase successful inter-area movements.

Ramler JP, Hebblewhite M, Kellenberg K, Sime C. 2014. Crying Wolf? A Spatial Analysis of Wolf Location and Depredations on Calf Weight. *American Journal of Agricultural Economics* 96(3):631-56. DOI:10.1093/ajae/aat100.

Historically, studies examining the impact of predators such as wolves on domestic livestock have been conducted using direct depredation rates (e.g., Sommers et al. 2010, Muhly and Musiani 2009, Bradley and Pletscher 2005). However it has been suggested that predators may have impacts on livestock that reach beyond direct depredation (Kluever et al. 2008, Howery and DeLiberto 2004).

One claim in particular is that wolves decrease the average weight of calves (Alderman 2006, Steele et al. 2013) by stressing mother cattle, increasing movement rates, or encouraging inefficient foraging behavior. Using data from Montana ranches and spatial data on known wolf pack locations and climatological data from 1995 to 2010, Ramler et al estimated the spatial impact of changing wolf pack locations and confirmed wolf depredations on the weight of beef calves.

The authors found no evidence that wolf packs with home ranges that overlapped ranches had any detrimental effects on calf weights. Other non-wolf factors, notably climate and individual ranch-specific husbandry practices, explained the majority of the variation in weight. However, ranches that experience a confirmed cattle depredation had a negative and statistically significant impact on the average calf weight across their herd.

For ranches experiencing confirmed depredation, these indirect costs are shown to be potentially greater than direct depredation costs. Ramler et al. suggest these results demonstrate a potentially important and understudied aspect of economic conflict arising from the protection and funding of the endangered species recovery programs.

Rich LN, Mitchell M S, Gude JA, Sime CA. 2012. Anthropogenic Mortality, Intraspecific Competition, and Prey Availability Influence Territory Sizes of Wolves in Montana. *Journal of Mammalogy* 93(3):722. DOI:10.1644/11-MAMM-A-079.2.

Rich et al. examined factors determining wolf pack territory sizes in Montana and determined that terrain ruggedness, human densities, prey availability, and number of surrounding wolf packs were all factors predicting territory sizes. The authors also found a strong positive relationship between lethal controls and territory size, with the mechanism behind this relationship remaining unclear. The authors did not test the changing social dynamics within packs through the removal of breeders or experienced pack members and concluded that further exploration of the relationship between lethal controls and territory size is needed.

Richie L, Oppenheimer JD, Clark SG. 2012. Social Process in Grizzly Bear Management: Lessons for Collaborative Governance and Natural Resource Policy. *Policy Sciences* 45(3):265-91. DOI:10.1007/s11077-012-9160-z.

After years of acrimony and deprivation of values among many participants in the grizzly bear debate, in 2005 Parks Canada initiated a small-scale trial intervention with the goal of learning about a system and improving outcomes (Willard and Norchi 1993, Lasswell and McDougal 1992). This Grizzly Bear Dialogue Group (GBDG) convened a small number of diverse stakeholders to meet regularly to discuss grizzly bear issues and generate management recommendations whose overriding goal was to advance human dignity (Clark 2011).

Richie et al. mapped and appraised the GBDG's social process and examined lessons learned from the process that was uniquely grounded in and directly applying the policy sciences while representing years of stakeholder collaboration. The authors found that the GBDG was a direct and practical application of the policy sciences' problem solving approach to real-life and high-profile natural resource problems. They suggest that an effective social process is critical to fostering participants' collective ability to find common ground.

Rigg R, Findo S, Wechselberger M, Gorman ML, Sillero-Zubiri C, MacDonald DW. 2011. Mitigating Carnivore-Livestock Conflict in Europe: Lessons from Slovakia. *Oryx* 45(2):272-80. DOI:10.1017/S0030605310000074.

Large carnivores can coexist with humans given favorable management policy (Linnell et al 2001) but, to avoid a return to unsustainable levels of lethal control, there is a need to mitigate conflicts in ways that are both effective and acceptable (Sillero-Zubiri and Laurenson (2001).

In Slovakia, a 30-year moratorium on hunting allowed the brown bear to recover (Rigg and Adamec 2007). Grey wolf and Eurasian lynx numbers also increased (Rigg 2008 and 2004). Slovakia also instituted a compensation program, regulated hunting, and several non-lethal measures for mitigating conflict.

To identify effective, acceptable coexistence techniques, Rigg et al. assessed damage, mitigation measures, and public opinion about livestock predation in Slovakia, focusing on compensation records, analysis of farm conditions, surveys and interviews, diet analysis, and livestock-guarding dogs.

They found that economic damage, while inconsequential nationally, was high locally; grey wolves appeared responsible for significantly more damage than black bears; losses to Eurasian lynx were negligible; and shepherds had the most negative attitudes, particularly toward wolves, despite compensation. They also found that use of livestock guarding dogs was associated with fewer losses.

Conflicts were unevenly distributed, with much variation explained by local conditions and husbandry practices, especially preventative measures. The authors suggest that identifying vulnerable farms and targeting them for mitigation could reduce damage, and livestock guarding dogs are particularly appropriate where wolves are present.

Robinson HS, Wielgus RB, Cooley HS, Cooley SW. 2008. Sink Populations in Carnivore Management: Cougar Demography and Immigration in a Hunted Population. *Ecological Applications* 18(4):1028-37. DOI:10.1890/07-0352.1.

Sport hunting is widely invoked as an effective tool for reducing human-carnivore conflicts while maintaining viable populations. However, the way in which carnivore populations respond to harvests can vary greatly depending on their social structure, reproductive strategies, and dispersal patterns.

Although hunting cougars on a broad geographic scale can reduce densities, hunting in smaller areas, such as game management units, could conceivably be counterproductive (in terms of reducing populations or conflicts) because it can fuel increased immigration from adjacent source areas.

Robinson et al. monitored a heavily hunted cougar population to test for the effects of hunting at a small scale, and to gauge whether population control was achieved or whether hunting losses were negated by increased immigration.

The authors observed no decline in the density of the total population or the adult population within their study area, but observed a significant decrease in the average age of independent males. They found that the male component of the population increased, masking a decrease in the female component. Overall, the authors' data support a compensatory immigration sink hypothesis—cougar removal in small game management areas increased immigration and recruitment of younger animals from adjacent source areas, resulting in little or no reduction in local cougar densities and a shift in population structure toward younger animals. Hunting in high-quality habitats may create an attractive sink, leading to misinterpretation of population trends and masking overall population declines in the sink and surrounding source areas.

The authors argue that informed management decisions require an accurate assessment of carnivore abundance and population rates. Hunting pressures can often be concentrated in areas that have high habitat quality and therefore highest cougar densities. Robinson et al.'s findings show that these same hunted areas probably act as sinks, maintaining stable populations through increased immigration from surrounding source areas. If population estimates are based on these heavily hunted sink populations, off-take of recent immigrants could produce the illusion of a growing population in the greater region.

Roever C, Boyce M, Stenhouse G. 2010. Grizzly Bear Movements Relative to Roads: Application of Step Selection Functions. *Ecography* 33:1113-22. DOI:10.1111/j.1600-0587.2010.06077.x.

Access management is an important facet of grizzly bear conservation in North America. Understanding how bears move relative to human travel corridors is important in contexts where most grizzly bear mortalities are human-caused. Roever et al. examined how bears move relative to roads in Alberta, where nearly all grizzly bear mortalities are caused by humans and occur near roads and trails. The authors applied step-selection functions to model habitat selection and movements of grizzly bears.

Roever et al. found that bears of both sexes and all ages were more likely to select steps closer to roads, irrespective of traffic volume. Roads are associated with attractive habitats for bears (such as forestry/logging cut blocks, which are associated with several grizzly bear foods in this area). Models substituting cut blocks for roads outperformed road models in predicting bear selection during day, dawn, and dusk.

Bear step lengths increased near roads and were longest near highly trafficked roads indicating faster movements when near roads. Bear selection of roads was consistent throughout the day. Nevertheless, time of day had a strong influence on selection of forest structure and terrain variables. At night and dawn, bears selected forests of intermediate age, and chose older forests during the day. Solar radiation values were selected-for at dawn. Bears chose steps closer to edges at dusk.

Roever et al. note other studies finding that grizzly bear avoidance of roads was contingent on traffic volume near highways (as well as less-trafficked logging roads). They also point out that inferring causation is challenging in regard to these observations. The authors postulate that roads are an attractant because they are associated with cut blocks (which contain bear foods) and because they are located in appealing lower-elevation valley habitats. But roads are also a source of mortality, so increasing step-length may be due to quicker movement or straighter path to reduce time spent at risk near roads. At night, roads also can provide convenient trails between cut blocks or other food patches, so roads are used for travel, again resulting in longer step lengths.

To decrease bear mortality near roads, the authors argue that managers must either reduce sources of attraction near roads or reduce sources of mortality. Several tools are available to address these challenges. When grizzly bear habitat preferences overlap human activities, the likelihood of human-bear interactions (and attendant conflicts) increases. Mitigating or reducing this overlap will aid in grizzly bear conservation.

Rosen T, Hussain S, Mohammad G, Jackson R, Janecka J, Michel S. 2012. Reconciling Sustainable Development of Mountain Communities with Large Carnivore Conservation. *Mountain Research and Development* 32(3):286-93. DOI:10.1659/MRD-JOURNAL-D-12-00008.1.

While the world is becoming increasingly interconnected and interdependent, physically and culturally, the wildlife of remote mountain regions is being affected both positively and negatively by such interconnectedness. In the case of snow leopards, the conservation impact has been largely, and rather unexpectedly, positive.

Rosen et al. studied the effective strategies to mitigate and reduce wildlife-human conflict through Project Snow Leopard (PSL), which takes place in small independent communities in Northern Pakistan, with a focus on snow leopard-livestock conflicts.

In the communities studied, ranching/livestock is the major occupation and backbone of the economy. Two major carnivores, the snow leopard and wolf, live in the area and prey on domestic livestock, often causing economic damage and threatening village-level food security, and causing retaliatory killing of predators in response to depredations, often wiping out entire packs of animals.

PSL's approach to reducing the economic burden of livestock loss was to set aside a collective pool of money equal to the value of the average annual loss rate, which they call the insurance scheme approach. This allowed the community to spread the risk and reduce the impact of losses. The project also used mitigation measures, such as the use of predator-proof corrals and community empowerment/education.

Through PSL, Rosen et al. examined the effectiveness of incentive programs with the rise of wildlife-human-conflicts worldwide. Their research shows that while the incentive component is critical, it should be part of a larger approach that includes developing and supporting local government and agencies, improving access to education and tolerance of wildlife (particularly predators), and offering a range of tools to reduce the conflict that can be implemented locally.

Rush T, Haroldson M, Murphy K, Boutte P, Hornocker M, Quigley H. 2011. Cougar Survival and Source-Sink Structure on Greater Yellowstone's Northern Range. *Journal of Wildlife Management* 75(6):1381-98. DOI:10.1002/jwmg.190.

Cougars have a great ability to persist in a variety of habitats, provided there is adequate cover and prey. However, habitat quality may vary spatially and temporally and affect cougar survival and production. Ultimately, survival of individuals and population resiliency may be strongly influenced by various factors including land use (roads, livestock, development), management through hunting and depredation removal, and by competition with other carnivores.

Rush et al. studied survival and causes of mortality of radio-collared cougars in the Greater Yellowstone Northern Range (GYNR) prior to (1987–1994), and after (1998–2005), wolf reintroduction and evaluated temporal, spatial, and environmental factors that explain variation in adult, sub-adult, and kitten survival.

The authors found that the most significant determinants of survival were age and sex of the cougar, elevation, and density of roads in a cougar's home range during the cougar hunting season. Survival increased as females and males aged but then rapidly declined at older ages, around 8 to 10 years. Generally, female cougars in the study area had higher survival than males.

The possible effect of increased wolf presence on survival was small compared with effects of age, sex, elevation, and density of roads during the hunting season. Wolves caused 15% of adult cougar deaths and all occurred during winter. Although the influence of increasing wolf presence and use is not clear from the survival modeling, cougars responded to increasing wolf use by concentrating their activities in more topographically complex habitats.

Low elevations and increasing density of roads, particularly in areas open to hunting, posed greater mortality risk for cougars than in areas of low road density and higher elevations. The findings support other cougar studies and are consistent with findings for other carnivores, like grizzly bears.

Ruth TK, Logan KA, Sweanor LL, Hornocker MG, Tample LT. 1998. Evaluating Cougar Translocation in New Mexico. *Journal of Wildlife Management* 62(4):1264-75.

Translocation of cougars may become an increasingly important management and conservation technique due to changing cultural attitudes toward nontraditional methods of predator control. Ruth et al. conducted a two-year study of translocated cougars with known social and behavioral histories, to evaluate the feasibility of translocation as a cougar management tool.

The outcome of cougar translocation seems to be influenced by the sex, age, and social status of the individual prior to translocation. Translocation was most effective for cougars who had not established residency or social dominance prior to relocation. These cougars exhibited limited post-release movements, quickly established home ranges or use-areas near release sites, and had better survival (50%) over the course of the study.

Translocation was not effective for reproducing females of territorial males. They demonstrated the greatest movements away from release sites and stronger homing tendencies. Older-age cougars with long-established home ranges within source populations did not move far from release sites and were subsequently killed by other cougars, suggesting high immediate mortality risks for these groups.

Ruth et al. suggest that translocation is not a reliable alternative for dealing with cougars that attack humans, primarily because of the unpredictable movements demonstrated by translocated cougars. Independent young cougars (12-27 months old) that prey on livestock or pets may successfully be translocated to remote cougar habitat that does not contain livestock or human residential areas with pets and is large enough to accommodate initial exploratory movements away from release sites and the establishment of a suitable home range. The authors suggest that cougars that overlap or encounter human development pose complex management problems that should be dealt with case-by-case.

Rutherford MB, Gibeau ML, Clark SG, Chamberlain EC. 2009. Interdisciplinary Problem Solving Workshops for Grizzly Bear Conservation in Banff National Park, Canada. *Policy Sciences* 42:163-87.

Developing and implementing successful conservation strategies requires scientists, managers, and advocates to accurately identify the problems, assess what knowledge is needed, integrate information from a variety of sources to develop a reliable understanding of the causal factors underlying problems, and generate effective solutions that are in the common interest.

Rutherford et al. reported on the outcomes from a series of workshops in Canada designed to explore how cognizant participants were of their own standpoints, and how that influenced their perceptions of problems and solutions, in order to engage constructively with each other.

The workshops highlighted five ways in which the policy sciences framework can help collaborative decision-makers be more effective: (1) by encouraging comprehensive thinking about the context for problems, thereby increasing the probability that all of the important variables and concerns relevant to a proposed solution will be taken into account; (2) by guiding participants sequentially through tasks of problem orientation, the framework can help them move beyond simply arguing about trends and promoting preferred alternatives; (3) by encouraging careful consideration of appropriate goals for social and decision-making processes, in addition to traditional goals for biological conservation; (4) by asking participants to examine their own standpoints and consider how their identity and biases shape their own thinking; and (5) talking about social and decision-process issues allowed participants to find common ground, even if they do not initially agree on specific bear management policies.

The authors suggest that their workshops were successful in improving communication within the local community, developing integrated problem solving skills, building understanding and trust, and beginning the process of improving outcomes for bears and people. They offer their approach as a model for pursuing these outcomes in other settings.

Rutledge LY, Patterson BR, Mills KI, Loveless KM, Murray DL, White BN. 2010. Protection from harvesting restores the natural social structure of eastern wolf packs. *Biological Conservation* 143:332-39. DOI:10.1016/j.biocon.2009.10.017.

Human-caused mortality impacts the social dynamics of wolves, and understanding these effects is relevant to managing populations effectively. Strictly numerical approaches to population management fail to account for key factors relating to natural social structure. Rutledge et al. examined ecological and genetic data in Algonquin Provincial Park and adjacent lands in Ontario, Canada, to show that reduced anthropogenic mortality restored the natural kin-based social structure of wolf groups, without a marked change in overall density.

There is growing evidence that maintaining kin relationships in socially structured populations is evolutionarily important and can have positive effects on fitness. Intense harvest may increase adoption of unrelated individuals into packs. High human-caused mortality, even on the periphery of relatively large protected areas, seems to lead to low kinship within packs. This is an issue in terms of restoring not only viable, but also naturally-functioning populations.

The influence of family-based social structures is not well understood in wolves. Nevertheless, Rutledge et al. generally affirm the importance of maintaining the integrity of natural social groups, particularly when viewed in conjunction with studies describing the effects of breeder loss events.

Sandstrom A, Lundmark C. 2016. Network Structure and Perceived Legitimacy in Collaborative Wildlife Management. *Review of Policy Research* 33(4):442-62. DOI:10.1111/ropr.12180.

Institutional reforms that embrace ideas of collaborative management have increased due to the complexity of contemporary policy problems and the shortcomings of traditional public management (Agranoff and McGuire 2001, Ansell and Gash 2008, Kicker et al. 1997, Koopenjan and Klijn 2004, McGuire and Agranoff 2011). This collaborative trend is manifested particularly within the

environmental sector, in which scientific scholars and policy makers have called for more participatory approaches, stakeholder inclusion, and co-management (Armitage et al. 2009, Bromley 1992, Driessen et al. 2012, Reed 2008).

Sandstrom and Lundmark examined three Swedish state-initiated and interest-based collaborative Wildlife Conservation Committees (WCCs) to determine if there was a link between social network structures in collaborative management arenas and the perceived legitimacy of output by policy stakeholders.

The authors confirmed the notion that collaborative arenas consisting of high network closure with strong and numerous ties across organizational boundaries enjoy a higher level of support among stakeholders directly involved in management through their WCC membership than do networks with sparse structures. They conclude that this type of well-integrated network structure seemingly increases stakeholders' understanding of others' perspectives, and urge further research on this strategy.

Sawaya MA, Clevenger AP, Kalinowski ST. 2013. Demographic Connectivity for Ursid Populations at Wildlife Crossing Structures in Banff National Park. *Conservation Biology* 27(4):721-30. DOI:10.1111/cobi.12075.

Wildlife crossing structures are one solution to mitigating the fragmentation of wildlife populations caused by roads, but their effectiveness in providing connectivity has only been superficially evaluated. Hundreds of grizzly and black bear passages through under and overpasses have been recorded in Banff National Park, Alberta, Canada. However, the ability of crossing structures to allow individual and population-level movements across road networks remains unknown.

Sawaya et al. initiated a 3-year investigation into whether crossing structures provide demographic connectivity for grizzly and black bears in Banff National Park. They collected hair with multiple noninvasive methods to obtain genetic samples from grizzly and black bears around the Bow Valley, in order to determine the number of male and female grizzly and black bears that use crossing structures; examine spatial and temporal patterns of crossings; and estimate the proportions of grizzly and black bear populations in the Bow Valley that use crossing structures.

The number of individuals detected at wildlife crossing structures was highly correlated with the number of passages in space and time. Grizzly bears used open crossing structures (e.g., overpasses) more often than constricted crossings (e.g., culverts). Peak use of crossing structures for both bear species occurred in July, when high rates of foraging activity coincide with mating season. The authors compared the number of bears that used crossings with estimates of population abundance from a related study and determined that substantial percentages of grizzly and black bear populations used crossing structures. Sawaya et al. concluded wildlife crossing structures provide demographic connectivity for bear populations in Banff National Park.

Sazatornil V, Rodriguez A, Klaczek M, Ahmadi M, Alvares F, Arthur S, Blanco JC, Borg BL, Cluff D, Cortes Y, Garcia EJ, Geffen E, Habib B, Iliopoulos Y, Kaboli M, Krofel M, Llaneza L, Marucco F, Oakleaf JK, Person DK, Potocnik H, Razen N, Rio-Maior H, Sand H, Unger D, Wabakken P, Lopez-Bao JV. 2016. The Role of Human-Related Risk in Breeding Site Selection by Wolves. *Biological Conservation* 201:103-110. DOI:10.1016/j.biocon.2016.06.022.

Wolves are the most widely distributed large carnivore species with which humans share the landscape (Mech and Boitani 2003). However, coexistence is largely variable in terms of interaction attributes and conflict intensity (e.g., Agarwala and Kumar 2009, López-Bao et al. 2013, Chapron et al. 2014). Wolves are resilient and able to thrive under a wide spectrum of biotic and abiotic conditions (Mech and Boitani 2003). As a consequence, they have traditionally been considered habitat generalists, with habitat tolerance mainly shaped by food availability and mortality risk (Mech and Boitani, 2003). Such constraining factors of habitat tolerance are the same for most large carnivore species (Woodroffe and Ginsberg 1998, Fuller and Sievert, 2001). Therefore, wolves are a good model species for gaining a better understanding of the behavioral adaptations of large carnivores to humans.

Using data from 26 study areas across wolves' worldwide range, Sazatornil et al. assessed the role of humans in breeding site selection by a large carnivore. Some of the patterns previously observed at the local scale become extrapolatable to the entire species range provided that important sources of variation were taken into account. Generally, wolves minimized the risk of exposure at breeding sites by avoiding human-made structures, selecting shelter from vegetation and avoiding agricultural lands.

The authors' results suggest a scaled hierarchical habitat selection process across selection orders by which wolves compensate higher exposure risk to humans within their territories via a stronger selection at breeding sites. Dissimilar patterns between continents suggest that adaptations to cope with human-associated risks are modulated by the history of coexistence and persecution. Although many large carnivores persisting in human-dominated landscapes do not require large-scale habitat preservation, habitat selection at levels below occupancy and territory should be regarded in management and conservation strategies aiming to preserve these species in such contexts. In this case, the authors recommend providing shelter from human interference at least in small portions of land in order to fulfill the requirements of the species to locate their breeding sites.

Schwartz CC, Haroldson MA, White GC. 2010. Hazards Affecting Grizzly Bear Survival in the Greater Yellowstone Ecosystem. *Journal of Wildlife Management* 74(4):654-67. DOI:10.2193/2009-206.

During the past two decades, the grizzly bear population in the Greater Yellowstone Ecosystem has increased in numbers and expanded in range. Early efforts to model grizzly bear mortality were principally focused within the Fish and Wildlife Service Grizzly Bear Recovery Zone, which currently represents only about 61% of known bear distribution in the GYE.

A more recent analysis that explored one spatial covariate that encompassed the entire GYE suggested that grizzly bear survival was highest in Yellowstone National Park, followed by areas in the grizzly bear Recovery Zone outside of the park, and lowest outside of the Recovery Zone. Although management differences within these areas partially explained differences in grizzly bear survival, these simple spatial covariates did not capture site-specific reasons why bears die at higher rates outside the Recovery Zone.

Using recent data (1983-2003) from radio-marked bears, Schwartz et al. examined grizzly bear mortality in the GYE in an effort to better understand drivers of bear mortality and their relationship to landscape features (i.e., foods, land management policies, human disturbance factors). They found that survival of independent (age ≥ 2 years) grizzly bears was best explained by the level of human development on the landscape within their home range. Bear survival improved as secure habitat and elevation increased, but declined as road density, number of homes, and site developments increased. Also of note: bears living in areas open to fall ungulate hunting suffered higher rates of mortality than bears living in areas closed to hunting.

Schwartz et al.'s analysis highlights the significance of human activity in terms of predicting bear mortality. Conservation efforts will hinge, to large extent, on mitigating those human factors. Mature whitebark pine is declining in the GYE. Grizzlies will likely increase their use of lower-elevation habitats, where mortalities are typically higher because lower-elevation habitats tend to be more developed with higher human traffic, with associated hazards. The authors recommend that land-management agencies focus on these low-elevation habitats to maintain or improve security for bears.

Schwartz C, Haroldson M, White G, Harris R, Cherry S, Keating K, Moody D, Servheen C. 2006. Temporal, Spatial, and Environmental Influences on the Demographics of Grizzly Bears in the Greater Yellowstone Ecosystem. *Wildlife Monographs* 161:1-68.

Grizzly bear populations have increased numerically and spatially over the past two decades. Understanding the temporal, environmental, and spatial variables responsible for this change will help in terms of identifying beneficial management and conservation efforts. Schwartz et al. explored the relationship between demographic vigor and an array of individual, temporal, and spatial covariates.

Overall, changes in survival and reproduction in the Greater Yellowstone Ecosystem (GYE) were influenced by 3 principal factors: humans killing bears, changes in food abundance, and density-dependent factors affecting reproduction and survival of dependent young.

Schwartz et al.'s best models indicated that reproductive output, measured as cubs per litter, was most strongly influenced by indices of population size and whitebark pine cone production. Their data suggest a possible density-dependent response in reproductive output. Cub and yearling survival were most affected by residency in the GYE. Survival was highest for cubs and yearlings living outside Yellowstone National Park (YNP) but within the Grizzly Bear Recovery Zone (RZ). Cubs and yearlings living inside YNP had lower survival rates, and those living outside the RZ had the lowest survival rates. Survival rates were negatively related to a population index, suggesting density dependence. Survival improved with higher whitebark pine seed production, greater winter severity, larger litter size, and older mothers.

Most known mortalities (85.5%) were human caused. Best models indicated that females survived better than males, survival was lowest during autumn, and survival increased during years with good whitebark pinecone production. Indices of winter severity, ungulate biomass, and population size, plus individual covariates, including presence of dependent young, prior conflicts with humans, and age class were not important predictors of survival in the authors' models.

Schwartz et al. highlight that grizzly bears will require careful and adaptive management efforts, even if/as specific regulations and agency responsibilities change.

Schwerdtner K, Gruber B. 2007. A Conceptual Framework for Damage Compensation Schemes. *Biological Conservation* 134:354-60.

Most compensation schemes take the ex-post form which compensates injured parties after the damage has occurred, with the amount paid being based on an estimation of the actual damage costs that arise (e.g., paying a rancher the market value for a depredated cow). An alternative scheme takes the form of ex-ante compensation in advance. In these cases, compensation is paid ahead of time, based on average damages expected in a given area (e.g., paying all ranchers in an area a flat rate, based on average anticipated depredations). The main difference is the way that damage is assessed: either directly when the damage occurs, or indirectly and exclusive of actual individual damage occurrences.

Schwerdtner and Gruber examined damage compensation schemes as solutions to mitigate human-wildlife conflicts. They compared two broad frameworks for compensation—ex-post compensation and compensation in advance, in regard to the European otter in Germany. They found that the two types of schemes (ex-post and in-advance) differ widely in their transaction costs, and that their respective effectiveness is closely related to the temporal and spatial distribution of damages.

There are contexts in which either approach may be preferable over the other. The capacity for damage prediction is the first criteria when deciding which approach to take. Compensation in advance may be most applicable with wildlife whose effect on the landscape is more spatially and temporally homogenous rather than not. Ex-post schemes, in contrast, may be more suitable if damages cannot be easily predicted because of their variation in time or space (as with wolves).

Two important factors relate to ex-post schemes: transaction costs and incentives. Ex-post schemes do not provide any real incentive to prevent damage. Moreover, there is the problem of so-called moral hazard or hidden action. The responsible body is not in a position to perfectly monitor any defensive efforts by claimants. Likewise, verification and payment on an individual ex-post basis imposes high operating costs. It also imposes additional costs on the claimant, in terms of time and effort expended to pursue compensation.

Overall, the authors conclude, the choice between ex-post and in-advance compensation schemes depends primarily on the distribution of damages, which depends on the species of concern (and the quality of our predictive models).

Shivik JA. 2006. Tools For the Edge: What's New for Conserving Carnivores. *BioScience* 56(3):253-59.

Predator management requires effective tools to mitigate conflicts with livestock. Disruptive and aversive tools can all be useful. Husbandry practices (shed-lambing and night penning, intensive monitoring of flocks/herds), as well as broader scale decisions about when and where to graze in relation to predators, are well used and time-tested approaches to manage wolf-livestock conflicts.

Shivik focuses his discussion on more novel emerging tools and techniques including disruptive stimuli, delaying habituation to stimulus tools, guarding dogs, electric-shock training collars and electrified fladry, and various forms of physical harassment.

Shivik tabulates the biological and economic efficiency of many of these methods, and stresses the importance of using a diverse suite of tools, targeting methods to the time and place where they will be most effective. Habituating predators through indiscriminate over-application will undermine the effectiveness of any method.

Shivik JA, Treves A, Callahan P. 2003. Nonlethal Techniques for Managing Predation: Primary and Secondary Repellents. *Conservation Biology* 17(6):1531-37.

Primary repellants—like fladry or the newly developed Movement-Activated Guard (MAG)—immediately disrupt a predator’s actions. They rely on novelty and are rendered ineffective by exposure, learning, and habituation. In contrast, secondary repellants such as shock collars and less-than-lethal ammunition, rely on animal learning to be effective. They rely on aversive conditioning after a link is established between a behavior and a negative outcome. Some tools—guard dogs and electrified ‘turbo’ fladry—can function as both primary *and* secondary repellants.

Shivik et al. examined the effectiveness of fladry barriers (flagging interspersed and suspended on a strand of rope or twine) and the MAG on wolf behavior on six wolf territories in Wisconsin. The authors also compared the efficacy of a primary repellent (the disruptive stimulus device) versus a secondary repellent (electronic shock collars) amongst captive wolves. The disruptive stimulus device kept captive wolves from consuming a food resource, but did not produce an aversion to the resource (e.g., no effectiveness as a secondary repellent). With training collars, logistical and behavioral variability functionally curtailed the authors’ ability to condition wolves.

The authors highlight the complexity of applying nonlethal predation management techniques. Some quite effective tools are relatively complex, expensive, and require high amounts of upkeep. By definition, disruptive tools require selective and targeted use, which entails extra time spent in planning and deployment. It can likewise be difficult to aversively condition predators in real-world situations, precisely because it is hard to control the specificity of the aversion that is entrained (e.g., a bear shot by a rubber bullet may develop aversion to the person who shot it, but not the food resource it was using when it was shot). Shivik et al. suggest that this points to the favorability of utilizing a broad suite of nonlethal tools, tailoring individual management actions to the specific context.

Sjolander-Lindqvist A, Johansson M, Sandstrom C. 2015. Individual and Collective Responses to Large Carnivore Management: The Roles of Trust, Representation, Knowledge Spheres, Communication and Leadership. *Wildlife Biology* 21(3):175-85. DOI:10.2981/wlb.00065.

Overseeing the continued recovery, dispersal and management of large carnivore populations while simultaneously considering human viability and welfare requires delicately balancing local concerns for rural communities’ livelihood prospects and property vulnerability with international concerns for saving threatened species.

Sjolander-Lindqvist et al. examined how competing interests and power relationships in Sweden influence the governance and management of contested wildlife resources, including the interrelationships between broader biophysical, social, political, economic, and cultural contexts and

histories. The authors drew findings from a variety of social science disciplines and identified five recurrent concepts that must be understood and consciously applied to large carnivore governance and management. They suggest that these themes deserve further intradisciplinary elaboration and in-depth understanding.

Slagle K, Bruskotter JT, Singh AS, Schmidt RH. 2017. Attitudes Toward Predator Control in the United States: 1995-2014. *Journal of Mammalogy* 98(1):7-16. DOI:10.1093/jmammal/gyw144.

Predator control policies in the United States shifted in the latter half of the 20th century, largely in response to public outcry. However, few studies have assessed attitudes toward predator control at the national level.

Slagle et al. replicated measures from a 1995 study that assessed attitudes toward predator management in the United States to determine if public support for predator management and perceptions of the humaneness of specific management practices changed over the past 2 decades.

The authors found relatively minor shifts in attitudes toward predator management, but many of the management practices assessed were rated significantly less humane than in the previous survey. Respondents were generally supportive of predator management aimed at losses of agricultural or private property; however, nonlethal methods were perceived to be far more humane than lethal methods. They suggest that the public is generally supportive of predator control, but increasingly skeptical of the methods employed in control actions.

Slagle K, Bruskotter J, Wilson R. 2012. The Role of Affect in Public Support and Opposition to Wolf Management. *Human Dimensions of Wildlife* 17:44-57. DOI:10.1080/10871209.2012.633237.

Individuals process information through two systems: the experiential system, containing affect and emotion, and the analytic system, containing logic and normative rules. Ideally, wildlife management decisions should be based on thoughtful deliberation of facts (i.e. analytic); however, this idea assumes people are capable of turning off their emotions. Objectivity in information processing and decision-making is ideal for natural resource management agencies; however, the idea that one can divorce emotion and other biases from decisions is not consistent with the prevailing scientific evidence.

In this Internet survey, Slagle et al. studied motivated, informed individuals to investigate the role of both systems in wolf recovery policy choices. The authors focused on how a person's affective or emotional reaction to wolves impacts their decisions about wolf conservation efforts.

As the authors predicted, affect played a significant role in people's opinions on wolf recovery and conservation. They found individuals who participated in political activities were most likely to be those driving the policies regarding wolf management, and these individuals appeared to be heavily influenced by their negative or positive reaction to wolves. Responses reflecting intolerance toward wolves are driven by negative affect slightly more than those intentions reflecting stewardship are driven by positive affect. Slagle et al. found that beliefs about positive and negative outcomes were a greater direct driver for intentions to support than oppose wolf recovery.

Slagle K, Zajac R, Bruskotter J, Wilson, R, Prange S. 2012. Building Tolerance for Bears: A Communications Experiment. *Journal of Wildlife Management and Wildlife Monographs* 77(4):863-69.

Reducing human-bear conflicts and promoting public acceptance for bears is critical for establishing viable, robust bear populations. The public typically favors educational materials concerning bears rather than more aggressive management actions such as lethal control when it comes to wildlife management. Because of this, education as an intervention strategy is often a priority for wildlife managers in order to increase acceptance of wildlife, including black bears. Additionally, educational methods are less controversial, making them more appealing to wildlife managers because they have the potential to reduce or even eliminate the root cause of human-bear conflicts.

There is extensive research on wildlife acceptance capacities (WAC), showing that the acceptability of carnivore populations is often determined by the perceived risks and benefits of the species, as well as individual perceived control over potential conflict and the associated consequences. However, little research has been done on education efforts designed to directly manipulate the variables known to affect an individual's acceptance of a species.

Slagle et al. evaluated the use of educational efforts to increase acceptance of black bears to determine if acceptance increased with information to increase an individual's perception of benefits associated with bear populations, and perception of control over black bear encounters. The authors found that messages including only basic bear biology and behavior information or descriptions of the actions one can take to avoid conflict (which is generally the information found in education outreach materials) are not sufficient for promoting acceptance of bears. They found that only providing information about how best to avoid conflict may decrease acceptance. Further, they found information about the benefits of black bears increased acceptance among study participants; the largest change in acceptance resulted from communications that presented both the benefits of bears as well as the actions people can undertake to avoid conflicts in the first place.

Slagle et al. suggest including only benefits information without information about the actions one can take to reduce conflicts may increase acceptance but can be harmful, especially in areas where bear populations are robust and encounters more likely. They explain it is critical to provide people with the information necessary to reduce their risk of conflict, and conclude that it would be beneficial for wildlife managers to include information about the benefits of bears in educational materials.

Smith DW, Bangs EE, Oakleaf JK, Mack C, Fontaine J, Boyd D, Jimenez M, Pletscher DH, Niemeyer CC, Meier TJ, Stahler DR, Holyan J, Asher VJ, Murray DL. 2010. Survival of Colonizing Wolves in the Northern Rocky Mountains of the United States, 1982-2004. *Journal of Wildlife Management* 74(4):620-34. DOI:10.2193/2008-584.

After a roughly 60 year absence, wolves immigrated (1979) and were reintroduced (1995-96) into the Northern Rocky Mountains (NRM), where they were protected under the Endangered Species Act. Smith et al. used hazard models to assess wolf mortality risk in three wolf populations (central Idaho, northwest Montana, and Greater Yellowstone) to assess biological, habitat, and anthropogenic factors contributing to wolf mortality risk and whether federal protection was adequate to provide acceptably low hazards.

The authors found an overall annual survival rate of 75%, which is generally considered adequate for wolf population sustainability. Most recorded mortalities were human-caused (management removal, illegal take, etc.). Wolves whose territory contained abundant agricultural and private land as well as livestock had higher mortality risk than those that did not. Mortality risk was higher in northwest Montana, likely due to a lower proportion of high quality habitat on secure public land. Lower observed hazard in Greater Yellowstone and central Idaho were likely due to larger high-quality core habitat areas with more explicit protections and/or limited human presence.

These factors (and others not listed here) all highlight the significance of human-caused mortality in the recovering NRM populations. This is especially true in NW MT, although hazard to wolves will likely increase in central ID or Greater Yellowstone if human use/access increases there as well. Glacier National Park and the greater Bob Marshall Wilderness Area do not seem to function as a large refugium from which wolves can emigrate to the surrounding area. This underscores the significance of improving survival rates in northwest Montana by reducing conflicts and illegal killing.

The authors advocate for harvest regulations that enhance opportunities for natural dispersal between recovery areas, particularly linkages with Greater Yellowstone.

Smith ME, Linnell JDC, Odden J, Swenson JE. 2000. Review of Methods to Reduce Livestock Depredation: I. Guardian animals. *Acta Agriculturae Scandinavica*, Section A – Animal Science 50(4):279-90.

It is important to distinguish livestock guarding dogs (LGDs) from herding dogs. They are bred for different purposes and display distinct physical and behavioral characteristics that dispose them to their job. Most LGDs in use today are Eurasian breeds. As opposed to past centuries, LGDs today usually operate more-or-less independent of the herder (an artifact of less time spent monitoring livestock). As such they must be exceptionally well-bonded with livestock, which presents some unique training challenges.

Reported effectiveness of LGDs varies. It is also typically difficult to attribute depredation reductions to them alone, as LPDs are typically used in conjunction with other management tools and predation behaviors are exceedingly complex. Nevertheless, the majority of producers using dogs consider them an economic asset. They are reportedly effective in deterring bears and felids, as well as other canids.

LGDs can reduce predation and labor (i.e. producers may no longer need to confine or corral sheep nightly, sheep graze in a tighter flock and are easier to monitor). If night confinement is discontinued, pastures can be utilized more efficiently. They also allow for greater peace-of-mind and increased self-reliance in managing predator problems.

Although many problems associated with LGDs are minor and/or rare, LGDs do occasionally harass or kill livestock, stray and not guard livestock, act aggressively toward people, or interfere with herd dogs. LGDs cost money and require time and effort to train and supervise. They are subject to illness and premature death. Incorporation of a guarding-dog system can also cause reduced growth in livestock (stress induced) until they are accustomed to the presence of the dogs.

Smith et al. suggest that LGDs can be a viable management tool, especially when combined with other husbandry practices designed to mitigate depredation risk.

Sponarski CC, Semeniuk C, Glikman JA, Bath AJ, Musiani M. 2013. Heterogeneity among Rural Resident Attitudes Toward Wolves. *Human Dimensions of Wildlife* 18(4):239-48. DOI:10.1080/10871209.2013.792022.

Rural communities are often considered a homogeneous population in resource management, and wolf management is no exception. However, the increasing migration of residents into rural areas has created the potential for conflicts about land use and differing attitudes about natural resource management.

Sponarski et al. conducted a survey in southwestern Alberta to gather data regarding attitudes toward wolves and fear, and wolf management. They found that multiple attitudes exist in the region regarding wolves and wildlife management; attitudes that indicate greater diversity than previously thought in how the public feels about wolves on the landscape.

The study was conducted in three rural municipal districts—Foothills, Pincher Creek, and Willow Creek—a landscape characterized by rural settlements and converted open land utilized for livestock production and agriculture.

Consistent with other international findings (Glikman, Bath, & Vaske, 2010), the results suggested the rural population is not a homogenous attitudinal group. The differences between groups were meaningful and definable by different socio-demographic information such as whether a person was a livestock producer or a hunter, and by sex and education level.

Steele JR, Rashford BS, Foulke TK, Tanaka JA, Taylor DT. 2013. Wolf (*Canis lupus*) Predation Impacts on Livestock Production: Direct Effects, Indirect Effects, and Implications for Compensation Ratios. *Rangeland Ecol Manage* 66:539-44. DOI:10.2111/REM-D-13-00031.1.

Controversy over the reintroduction of wolves remains a frequent newspaper headline across the US Rocky Mountain region, much of it stemming from wolf depredation of livestock, which has steadily increased since reintroduction in 1995 (e.g., USFWS 2011). Given that the costs of large carnivore conservation are disproportionately borne by local livestock producers, the United States uses compensation for wolf damage to reduce conflicts and mediate negative attitudes toward the predators (Schwerdtner and Gruber 2007, Dickman et al. 2011).

Thought their ability to achieve conservation goals has been questioned (Boitani et al. 2010), designing effective compensation schemes requires a more thorough accounting of the costs—direct and indirect—large carnivores impose on livestock producers.

Using a stochastic budget model of a representative cow-calf operation in northwestern Wyoming, Steele et al. estimated the economic impact of both direct (death loss and injured calves) and indirect (decreased weaning weights, decreased conception rates, and increased cattle sickness) effects.

Their results suggest that short-run (year-to-year) financial impacts of indirect effects may be as large as or larger than direct effects. Steele et al. argue that including indirect effects implies that the compensation ratio necessary to fully offset financial impacts of wolves would need to be two to three times larger than the current compensation ratio used in Wyoming.

Stewart BP, Nelson TA, Laberee K, Nielsen SE, Wulder MA, Stenhouse G. 2013. Quantifying Grizzly Bear Selection with Natural and Anthropogenic Edges. *Journal of Wildlife Management* 77(5):957-64. DOI:10.1002/jwmg.535.

As edges represent the interface between distinct habitat patches, unique ecosystem characteristics may occur near them (Forman 1995, Fortin et al. 2000, Ries et al. 2004). Creation of edge habitat can increase mortality as species may be exposed to greater rates of predation (Gardner 1998, Nielsen et al. 2004b) and brood parasitism (Murcia 1995). However, edges may also improve habitat conditions by providing access to resources in distinct habitat patches in close proximity (Lay 1938, Forman 1995, Ries and Sisk 2004).

Stewart et al. studied grizzly bear habitat selection in relation to different landscape-level measures of edge, both natural and anthropogenic, using a database of GPS telemetry data from 2005 to 2009, from the foothills of the Rocky Mountains in west-central Alberta.

The authors found that in general females selected anthropogenic edges, whereas males selected natural edges. Both sexes selected the natural transition of shrub to conifer. Females had a greater selection ratio for road edges than males in all seasons, and males had a greater selection ratio for roads in the fall than in other seasons

Stewart et al. suggest that, given human access to bear habitat is often facilitated by anthropogenic edges, improved management of these features may minimize human conflicts. In particular, they highlight the importance of natural transition from shrub to conifer to grizzly bears.

Stone SA, Breck SW, Timberlake J, Haswell PM, Najera F, Bean BS, Thornhill DJ. 2017. Adaptive Use of Nonlethal Strategies for Minimizing Wolf-Sheep Conflict in Idaho. *Journal of Mammalogy* 98(1):33-44. DOI:10.1093/jmammal/gyw188.

While livestock losses to wolves represent a small fraction of overall livestock mortality, the response to these depredations has resulted in widespread conflicts including significant efforts at lethal wolf control to reduce impacts on livestock producers, especially those with large-scale grazing operations on public lands. A variety of nonlethal methods have proven effective in reducing livestock losses to wolves in small-scale operations but in large-scale, open-range grazing operations, nonlethal management strategies are often presumed ineffective or infeasible.

To demonstrate that nonlethal techniques can be effective at large scales, Stone et al. conducted a 7-year case study in which they strategically applied nonlethal predator deterrents and animal husbandry

techniques on an adaptive basis to protect sheep and wolves on public grazing lands in Idaho. They collected data on sheep depredation mortalities in the protected demonstration study area and compared these data to an adjacent wolf-occupied area where sheep were grazed without the added nonlethal protection measures.

The authors found that sheep depredation losses to wolves were higher in the Nonprotected Area (NPA) than in the Protected Area (PA). Furthermore, no wolves were lethally controlled within the PA and sheep depredation losses to wolves were the lowest loss rate among sheep-grazing areas in wolf range statewide. Wolves were lethally controlled in the NPA. They suggest that proactive use of a variety of nonlethal techniques applied conditionally can help reduce depredation on large open-range operations.

Suzuki N, Parker KL. 2016. Potential Conflict Between Future Development of Natural Resources and High-Value Wildlife Habitats in Boreal Landscapes. *Biodivers Conserv* 25: 3043-73. DOI:10.1007/s10531-016-1219-2.

Conservation of intact ecosystems to sustain populations of species and biodiversity has become increasingly urgent as the human population worldwide continues to increase, seeking room for expansion into previously undeveloped wild lands and new opportunities for extraction of natural resources to satisfy ever increasing demands (Wittemyer et al. 2008; Leroux and Kerr 2013; Geldmann et al. 2014).

For a long time, boreal lands were protected from resource development because of harsh climate, remoteness, and inaccessibility (Andrew et al. 2012, 2014). Now, cumulative effects from increasing development of multiple resources, such as timber, oil and gas, hydroelectric dams, and mining, have begun to alter compositions of biological communities largely because of habitat loss (Venier et al. 2014). Among wildlife in Canada's boreal zone, population declines and range contractions are pronounced for woodland caribou and grizzly bears; some populations have been extirpated near the southern border of the boreal zone (Venier et al. 2014). Despite the ongoing threats to biodiversity from various resource developments, current status of ecosystem health in the boreal zone has not been assessed fully because long temporal and broad spatial biological and ecological datasets as well as coordinated research efforts are lacking (Kreutzweiser et al. 2013).

Suzuki and Parker explored potential conflicts between future resource development and high-value habitats of large mammals in an undeveloped boreal landscape in northeast British Columbia. They found that greater proportions of high-value habitats for moose, elk, and wolves overlapped areas of high cumulative resource potential, and impacted both winter and the growing season. The authors recommend a quantitative and visual GIS approach to scenario planning in the region to maintain abundance and diversity of wildlife populations.

Sweanor LL, Logan KA, Hornocker MG. 2000. Cougar Dispersal Patterns, Metapopulation Dynamics, and Conservation. *Conservation Biology* 14(3):798-801.

Cougars once ranged throughout North America, but by the turn of the 20th century, humans had virtually extirpated cougars in eastern North America and, in the West, relegated them to the most

remote habitats (Young 1946, Nowak 1976). Recent recovery of the cougar throughout much of its western range can be attributed to regulated hunting of the species since the mid-1960s, the presence of large tracts of relatively undisturbed habitat, and pathways for dispersal.

Sweanor et al. examined cougar dispersal, emigration, and immigration in the San Andres Mountains, New Mexico, to quantify the effects of dispersal on the local population and surrounding subpopulations. They found that cougars in southern New Mexico exhibited a metapopulation structure in which cougar subpopulations were separated by expanses of non-cougar habitat and linked by dispersers. Males were observed to disperse significantly farther than females, were more likely to traverse large expanses of non-cougar habitat, and were probably the most responsible for nuclear gene flow between habitat patches.

Sweanor et al. suggest that protected cougar subpopulations can contribute to metapopulation persistence by supplying immigrants to surrounding subpopulations that are affected by fragmentation or offtake by humans. The authors argue that cougar population dynamics and dispersal behavior dictate that cougar management and conservation should be considered on a regional scale. They recommend that agencies managing cougars in fragmented habitats need to identify and map subpopulations that are sources, sinks, and vulnerable to extinction because of small size or poor connectivity. Long-term monitoring could help managers determine how human offtake will affect metapopulation dynamics and how development may degrade habitat and corridors.

Teichman KJ, Cristescu B, Darimont CT. 2016. Hunting as a Management Tool? Cougar-Human Conflict is Positively Related to Trophy Hunting. *BMC Ecology* 16(44):1-8. DOI:10.1186/s12898-016-0098-4.

When conflicts involve large mammalian predators that pose a perceived or real threat to humans and property, a common outcome is the lethal removal of the predator by management agencies, landowners, and/or hunters. In the case of predator-human conflict over depredation, it is suggested that carnivore killing by hunters may actually promote conflict (Treves and Naughton-Treves 2005) because of shifts in age composition (Robinson et al. 2008) and fairly quick recolonization of conflict areas (Conner et al. 1998).

Teichman et al. examined a dataset from 1979 to 2008 on human hunting of cougars and cougar-involved conflict in British Columbia, Canada, to test their young animal, problem animal, and human hunting hypotheses. They found that while some lethal management focused on targeted individuals could be one option for addressing conflicts, overall increases in human hunting can, in fact, be associated with increased conflict, especially for male cougars.

Treves A, Chapron G, Lopez-Bao JV, Shoemaker C, Goeckner AR, Bruskotter JT. 2015. Predators and the Public Trust. *Biological Reviews* 92(1):248-70. DOI: 10.1111/brv.12227.

Environmental movements and strict legal protections have fostered predator recoveries across the U.S. and Europe since the 1970s. Now subnational jurisdictions are regaining management authority from central governments for their predator subpopulations. Will the history of local eradication repeat or

will these jurisdictions adopt public trust thinking and their obligation to broad public interests over narrower ones?

Treves et al. reviewed the role of public trust principles in the restoration and preservation of controversial species. They looked beyond species endangerment to future generations' interests in sustainability, particularly non-consumptive uses, and examined how differences between traditional assumptions and scientific studies of interactions between people and predators impede evidence-based policy.

The authors explore many important facets of this topic and concur that without public trust principles, future trustees will seldom prevail against narrow, powerful, and undemocratic interests. Without conservation informed by public trust thinking predator populations will face repeated cycles of eradication and recovery. They suggest that their conclusions have implications for the many subfields of the biological sciences that address environmental trust assets from the atmosphere to aquifers.

Treves A, Jurewicz RL, Naughton-Treves L, Wilcove DS. 2009. The Price of Tolerance: Wolf Damage Payments after Recovery. *Biodivers Conserv* 18(14):4003-21. DOI: 10.1007/s10531-009-9695-2.

The costs of wildlife conservation distribute unequally across society. Compensation can potentially redress inequities and raise local tolerance for endangered wildlife that damage property. However, the rules for payments generate controversy, particularly as costs mount and species recover. In Wisconsin, gray wolf damage payments grew notably over 28 years and eventually undermined budgets for conserving other endangered species. Treves et al. measured attitudes to compensation among 1,364 state residents, including those who voluntarily contributed funds and those likely to receive compensation, and we interviewed elected officials about the politics of payment rules.

Most respondents endorsed compensation for wolf damages to livestock—even when wolves are no longer endangered—but opposed payments for wolf damage to hunting dogs on public land. Most donors opposed killing wolves and over one-fourth unconditionally rejected a wolf hunt. The authors predict the latter donors would stop contributing funds for compensation if the state were to implement a proposed wolf hunt. Controversy over payment rules reveals clashing values regarding wildlife between those receiving and those paying for compensation. Moreover, the costs of compensation ratchet up as endangered species recover and claims of entitlement expand. Hence, Treves et al. recommend conservationists use sunset clauses and an adaptive management of compensation programs.

Treves A, Krofel M, McManus J. 2016. Predator Control Should Not Be a Shot in the Dark. *Frontiers in Ecology and the Environment* 14(7):380-88. DOI:10.1002/fee.1312.

Killing top predators—such as wolves and leopards, which occasionally prey on livestock—has prompted concerns associated with ethical issues (Vucetich and Nelson 2014), effectiveness, and ecological impacts. Depletion of apex consumers has led to degradation of ecosystems and disruption of vital ecological processes worldwide (Estes et al. 2011, Ripple et al. 2014). As a result, traditional non-lethal methods have been reinstated and new approaches are being developed (Treves et al. 2009). However,

many lethal and non-lethal methods are implemented without first considering experimental evidence of their effectiveness.

Treves et al. evaluated evidence for interventions against carnivore predation on livestock in North American and European farms, and reviewed a selection of tests from other continents, to assess the global generality of their findings. They found a greater portion of non-lethal methods than lethal methods were effective in preventing carnivore predation on livestock.

Treves et al. recommend that policy makers suspend predator control efforts that lack evidence for functional effectiveness, and that scientists focus on stringent standards of evidence in tests of predator controls.

Treves A, Martin KA. 2011. Hunters as Stewards of Wolves in Wisconsin and the Northern Rocky Mountains, USA. *Society and Natural Resources* 24(9):984-94. DOI:10.1080/08941920.2011.559654.

Hunting advocates often argue that hunters champion conservation and generate revenue for wildlife management. Similarly, well-managed hunts will promote sustained, stable wildlife populations, and lead to reduced conflicts with game species. However, applying these notions to wolves is complicated by widespread intolerance for the species (as opposed to non-predator game such as ungulates or waterfowl). Treves and Martin used three surveys to assess hunter and non-hunter attitudes toward wolves (spanning 2001-2007, among 2,300 residents of MT, ID, WY, and WI).

The authors found widespread support for a regulated, public hunting season on wolves, albeit with some stipulations about the justifications for such a hunt. Findings did not show that nonhunters will oppose hunting, and supported the assertion that nonhunters endorse hunting as a conflict remedy. For their part, likely wolf hunters showed little inclination to conserve wolves. The majority of hunters were unsupportive of wolf conservation at the time of these surveys. In fact, the authors caution against assuming that hunters will support the conservation of wolves simply because they have done so in the past for other game species. Hunter attitudes may change following the widespread initiation of a wolf hunt, but such an assertion is conjecture at best; there was no basis for supporting that claim.

These surveys suggest nuanced and diverse views on wolf hunting. Less than 17% of respondents unconditionally opposed a hunt. An overall majority endorsed a wolf hunt, but that support was somewhat conditional on how the decision was framed. This reaffirms the complexity of the situation, as well as the significance of social/public discourse in defining 'acceptable' options. Treves and Martin suggest that policymakers should seek to understand the nuances of the stakeholder community if they wish to effectively conserve carnivores and balance human interests.

Treves, A., Naughton-Treves, L., Harper, E., Mladenoff, D., Rose, R., Sickley, T., Wydeven, A. 2004. Predicting Human-Carnivore Conflict: a Spatial Model Derived from 25 Years of Data on Wolf Predation on Livestock. *Conservation Biology*. 18(1):114-25.

With the recovery of many large carnivore populations in North America, including the gray wolf and grizzly bear, encounters between carnivores, livestock, and humans are increasing in many areas. As

carnivore populations are increasing, their habitat and range are expanding, often into the same areas as humans and domestic animals. Lethal tools such as poisoning, shooting, and trapping carnivores are used in response to human and livestock conflicts with humans. These control methods threaten carnivore conservation, and ultimately undermine the work of the Endangered Species Act of protecting these animals.

Using sites of past wolf attacks on livestock in mixed forest-agriculture landscapes in Wisconsin and Minnesota, Treves et al. present a method to predict sites of human-carnivore conflicts regionally. Previous research has shown that dense vegetative cover appears to favor livestock predation by wolves and other large carnivore; likewise, placing pastures around vegetated waterways may promote coyote predation on sheep. In addition, reports have shown a negative association between carnivore predation on livestock and the density of human roads and settlements.

Treves et al. found that wolf attacks on livestock in Wisconsin and Minnesota were not randomly distributed in space. They discovered wolves preyed on livestock in townships sharing a consistent set of landscape features across both states, despite dramatic differences in the two states' wolf population sizes, wolf control policies, and farm sizes.

The study found that pasture areas were strongly correlated with risk to livestock, likely because of high cattle densities. However, deer also prefer the same areas, so it is also possible wolves were following the deer and encounter cattle incidentally. Finally, Treves et al. found that coniferous forest, herbaceous wetland, and open water were all associated with lower risk for livestock across matched townships. However, open water and coniferous forest were associated with higher risk across matched farms.

Treves et al. suggest that policymakers and wildlife managers can use maps similar to the ones they used in the study to determine more precise management zones, helping to reduce and mitigate conflicts.

Treves A, Wallace RB, White S. 2009. Participatory Planning of Interventions to Mitigate Human-Wildlife Conflicts. *Conservation Biology* 23(6):1577-87. DOI:10.1111/j.1523-1739.2009.01242.x.

Treves et al. summarize recommendations from the literature pertaining to a range of human-wildlife conflict interventions. They classify these interventions as either direct (reducing severity or frequency of encounters with wildlife) or indirect (raising human tolerance for encounters with wildlife).

The authors attempt to clarify the focal point of intervention for a series of intervention types, and organize their recommendations using three criteria: cost effectiveness; wildlife specificity and selectivity; and sociopolitical acceptability. The authors note that some interventions can lead to diverse outcomes, and as with any management tool effectiveness is highly context-dependent.

The authors used workshops to validate and refine their insights. They argue that conservation actions will be more effective if the relative merits of interventions are evaluated in a case-by-case, systematic, and participatory manner. They argue for optimizing participation in conservation planning. This approach is clearly complicated by the fact that management interventions often engender powerful emotions and may invoke broader sociopolitical interests. Nonetheless, they suggest that participatory planning can generate diverse and highly effective approaches by promoting institutional flexibility and

explicitly incorporating local and 'informal' knowledge. Participation in these processes can also raise tolerance for management activities.

Urbigit C, Urbigit J. 2010. A Review: The Use of Livestock Protection Dogs in Association with Large Carnivores in the Rocky Mountains. *Sheep and Goat Research Journal* 25:1-8.

Livestock protection dogs (LPDs) are widely regarded as a good tool for mitigating wolf and bear conflicts with livestock, but LPDs have seen only limited use in North America. Herding dogs often work in and around flocks of North American sheep, but these breeds (such as the border collie) are distinct in form and function from Eurasian breeds selected specifically for their ability to fight and/or drive away large predators. Urbigit and Urbigit provide an overview of each Eurasian breed, its history, and individual advantages.

The authors recommend that LPDs be deployed in groups of two to five, with the objective of outnumbering and outweighing wolves in individual encounters. Individual dogs and breeds will have different behavioral and guarding tendencies, so the proper mix of traits in a group of LPDs will depend on specifics of context and may take time and readjustment.

They authors also discuss spiked collars as a tool to protect the dogs that accompany livestock. Spiked collars have only seen limited use in North America. Attaching iron to dogs when they may be exposed to very low temperatures is a frequent concern, as is the danger of collars becoming entangled in fencing or brush. The authors suggest that these concerns deserve attention so that they can be mitigated through specific design modifications. They argue that spiked collars may allow LPDs to function much more effectively—not only by improving survivability of encounters with predators, but also by deterring inter-pack aggression amongst groups of LPDs.

Urbigit and Urbigit argue that LPDs offer high economic efficiency and on-the-ground effectiveness. Some Northern Rockies livestock producers have successfully used these breeds and techniques developed by nomadic pastoral Eurasian cultures; wildlife management efforts would benefit from a more full incorporation of this range of tools. The authors recommend their incorporation into wildlife conflict management efforts in the Western U.S.

Van Bommel L, Johnson CN. 2012. Good Dog! Using Livestock Guardian Dogs to Protect Livestock from Predators in Australia's Extensive Grazing Systems. *Wildlife Research* 39(3):220-29. DOI:10.1071/WR11135.

Studies on the effectiveness of livestock guardian dogs (LDGs) are limited, and there are especially few rigorous studies of the factors influencing effectiveness (Gehring et al. 2010a). However, there is evidence that these dogs can be effective in protecting many types of livestock from many different predators (Gehring et al. 2010b, Hansen et al. 2002, Marker et al. 2005a, Ostavel et al. 2009, Rigg et al. 2011).

Van Bommel and Johnson evaluated LGDs in Australia to determine the factors influencing effectiveness, in particular in relation to scale of management. They also documented how LDGs are

managed in Australia, evaluated their cost effectiveness, and identified factors that influence numbers of dogs required in different property situations.

The authors found that reported effectiveness of LGD was high, especially when stock per dog was less than 100. They also found that the cost of obtaining an LGD was returned within 1 to 3 years. They conclude that when a sufficient number of LGDs are used, they can be as effective in protecting livestock when ranging freely on large properties with large numbers of livestock as they are in small-scale farming systems. They suggest that LGDs could play a major role in securing the viability of livestock businesses and reconciling people-predator conflicts.

Vernon ME, Bischoff-Mattson Z, Clark SG. 2016. Discourses of Elk Hunting and Grizzly Bear Incidents in Grand Teton National Park, Wyoming. *Human Dimensions of Wildlife* 21(1):65-85. DOI:10.1080/10871209.2016.1099766.

The Grand Teton National Park (WY) annual elk hunt, or elk reduction program, was legislated in 1950 to resolve a dispute over whether the federal or state government should have authority over wildlife management on Wyoming's public lands. The program allows joint management of the GTNP elk by the National Park Service and the Wyoming Fish and Game Department—the former mandated to preserve and protect natural resources, and the latter expected to conserve the state's wildlife and manage game species for hunting. The success of these approaches has been mixed, and there continues to be stakeholder disagreement over their appropriateness—the feed grounds and park elk hunt are both highly controversial, and calls for their termination have persisted for decades (Clark 2000, Smith 2012, Wilbrecht and Robbins 1979).

Vernon et al. analyzed opinion-editorials over an approximately two-year span and conducted 35 interviews in summer 2013 to examine how participants defined problems, used evidence, and advocated solutions in relation to two conflict incidents between hunters and grizzly bears during the elk hunts in 2011 and 2012. Their incident analysis found fundamental differences in public and agency expectations about the GTNP elk hunt and other regional wildlife management issues. These differences underlie persistent conflict over the park elk hunt and Jackson Hole, WY, elk management practices, and they fuel criticism of agencies challenged with the difficult task of jointly managing these resources.

Vernon et al. recommend a full appraisal of the hunt to clarify common interests among the different perspectives discussed therein, as well as substantive action to address them including development of a more inclusive decision-making process.

VonHoldt BM, Stahler DR, Bangs EE, Smith DW, Jimenez MD, Mack CM, Niemeyer CC, Pollinger JP, Wayne RK. 2010. A Novel Assessment of Population Structure and Gene Flow in Grey Wolf Populations of the Northern Rocky Mountains of the United States. *Molecular Ecology* 19:4412-27.

The long-term success of Northern Rocky Mountain (NRM) wolf recovery efforts will depend at least in part on the genetic structure and connectivity of subpopulations, along with the preservation of genetic variation. VonHoldt et al. analyzed DNA samples from Northern Rocky Mountain wolves from the three NRM recovery areas (Greater Yellowstone, Montana, and Idaho; 1995–2004) and found that the

population appeared to maintain high levels of variation—with low levels of inbreeding—throughout the study period.

The authors detected genetically effective dispersal among the three recovery areas. Genetic diversity was high throughout the study period. Lower observed levels of genetic variation in Montana were probably attributable to its small population size relative to the other recovery areas. Inbreeding coefficients were low, and overall results imply that genetic variation was maintained in the NRM wolf populations during the study. Despite the close proximity of regional subpopulations within established dispersal capabilities of wolves, population divergence seems to have increased toward the end of the study period.

This genetic differentiation is likely influenced by anthropogenic factors. While high-quality core habitat exists throughout much of the NRM study area, high human and livestock densities, as well as greater human access, characterize the areas surrounding and connecting each recovery area. Regional-scale study of survival and mortality for NRM wolves have shown increased mortality risk for yearlings, dispersers, and wolves living in areas of overlap with private land and livestock. These demographic and spatial dynamics, which are largely driven by anthropogenic factors, may be critical to the metapopulation dynamics of NRM wolves in the future, as they influence rates of natural dispersal and genetic connectivity between recovery areas.

VonHoldt et al. note that successful conservation of NRM wolves will rely on management decisions that promote natural dispersal dynamics and minimize anthropogenic factors that reduce genetic connectivity.

Vucetich JA, Bruskotter JT, Nelson MP, Peterson RO, Bump JK. 2017. Evaluating the Principles of Wildlife Conservation: A Case Study of Wolf (*Canis lupis*) hunting in Michigan, United States. *Journal of Mammalogy* 98(1):53-64. DOI:10.1093/jmammal/gyw151.

The considerations that arise in addressing the appropriateness of predator control vary greatly with context, such as species, the extent of impacts, and the justifications provided for control. Because considerations vary, it may be impossible to conclude that predator control is universally wrong or universally acceptable—in other words, the appropriateness of predator control likely depends on the details of each case.

In Michigan, wolves were removed from the list of United States endangered species in December 2011. By June 2013, plans had been finalized to begin hunting wolves in fall 2013. According to these plans, a purpose of the hunt was to reduce wolf abundance in particular regions of Michigan to reduce threats to livestock and human safety.

Vucetich et al. evaluated the hunting plans using two basic tenets of wildlife management—the North American Model of Wildlife Conservation’s seven principles and the clarity, capacity to meet, and appropriateness of the management action’s purpose or goal. The authors found that plans for hunting wolves in Michigan appeared not to meet the principles of either tenet, and suggest that either wolf hunting as it has been planned in Michigan is inappropriate or both sets of standards for evaluating wildlife management are inappropriate.

The authors suggest the results of this case study are consistent with the idea that hatred is the reason people want to kill wolves. If so, and if science is not equipped to determine the “need” to hunt wolves, the authors argue that the question of whether to hunt wolves is not fundamentally a technical problem best solved by professionals, but instead a fundamentally normative issue.

Wallach AD, Ramp D, O’Neill AJ. 2017. Cattle Mortality on a Predator-Friendly Station in Central Australia. *Journal of Mammalogy* 98(1):45-52. DOI:10.1093/jmammal/gyw156.

In Australia, dingoes are subjected to intensive culling operations that aim to reduce predation on sheep and calves. Several local, state, and territory governments encourage killing by declaring dingoes “pest” species and by offering bounties. In some regions landholders are legally obligated to control dingoes (New South Wales Government 2015).

One of the most significant welfare and ecological impacts of killing socially complex species such as dingoes is the disruption of their social groups (Haber 1996, Bryan et al. 2015). The impact of lethal control extends beyond the individuals killed, harming surviving family members and changing population structure and ecological function (Wallach et al. 2015).

Wallach et al. studied the causes of cattle deaths over two years on a large predator-friendly cattle station in central Australia, to see if protecting dingoes would increase their social stability and would not cause an increase in cattle depredation.

The authors found that husbandry-related challenges associate with deteriorating environmental conditions were the leading causes of cattle deaths. Predation by dingoes was minor and declined as indices of dingo abundance stabilized and social stability increased. They suggest that shifting from killing predators to improving husbandry standards is likely to improve livestock survival and welfare.

Wallach AD, Ritchie EG, Read J, O’Neill AJ. 2009. More Than Mere Numbers: The Impact of Lethal Control on the Social Stability of a Top-Order Predator. *PLoS ONE* 4(9):e6861. DOI:10.1371/journal.pone.0006861.

Population control of socially complex species may have profound ecological implications that remain largely invisible if only their abundance is considered. Since European occupation of Australia, dingoes have been controlled over much of the continent. Wallach et al. examined the effects of lethal control on dingoes, which, as a socially complex top-order predator, can function as a rough model for other social predators. The authors assessed changes in dingo abundance and social stability following relaxation and intensification of lethal control efforts.

Wallach et al. found that signs of social stability steadily increased the longer an area was allowed to recover from lethal control, but change in dingo abundance did not follow a consistent path. Control actions appeared to severely fracture social groups, and the effect of control on abundance was neither consistent nor predictable.

While the specific mechanisms by which lethal control effect social populations are complex and highly contextual, this study highlights that abundance and social stability are not necessarily linearly related. Likewise, lethal removal can have highly deleterious effects on social stability. Researchers often focus solely on abundance, because assessing social stability may not always be feasible due to constraints on research time and resources. However, management decisions should not be based on estimates of abundance alone. It is vital to consider social stability if the goal is to ensure the conservation *and* ecological function of socially complex top-order predators.

Way J, Bruskotter J. 2012. Additional Considerations for gray wolf management after their removal from endangered species act protections. *Journal of Wildlife Management* 76(3):457-61.

Way and Bruskotter discuss wolf management, post-endangered species act delisting. They agree generally with others (Mech 2010) that the use of lethal management should be focused in areas of conflict and less in wilderness areas, especially near protected areas of habitat like national parks. They enumerate and expand upon several other points, which they suggest will make management plans more palatable to an increasingly diverse group of interested stakeholders, including: use of human dimensions research; employing preventative measures to protect livestock and pets; and, selective use of sport hunting.

Way and Bruskotter discuss ways in which wolf management controversy might be reduced, and whether wolf harvests reduce conflicts with livestock. They highlight the selective application of lethal techniques—targeting and structuring them to those contexts where wolf impacts and conflict are significant, and to situations where they can be expected to make a substantive difference.

In the authors' view, effective and publicly acceptable management scenarios would first employ proactive non-lethal methods, and encourage husbandry practices in an attempt to avoid conflicts in the first place. In these areas, managers would encourage non-depredating packs to live in multi-generational, social stable groups that teach their offspring to avoid humans and livestock. In areas where conflicts occur despite attempts at non-lethal coexistence, Way and Bruskotter advocate selective use of sport hunting to reduce wolf populations (as opposed to hunting as the de facto management tool). This might be accomplished by matching potential wolf hunters with affected producers/areas.

Wielgus RB, Peebles KA. 2014. Effects of Wolf Mortality on Livestock Depredations. *PLoS ONE* 9(12). DOI: 10.1371/journal.pone.0113505.

Gray wolves are currently being hunted in Idaho, Wyoming, and Montana in part to reduce livestock depredations. However, the long-term effectiveness of lethal wolf control to reduce livestock depredations is not known.

Wielgus and Peebles analyzed wolf depredation of livestock data in each state for each year from 1987 through 2012. Their results do not support the “remedial control” hypothesis of predator mortality on livestock depredations the following year. However, lethal control of wolves appears to be related to increased depredations in a larger area the following year.

While lethal control of individual depredating wolves may sometimes be necessary in the near-term, they recommend that non-lethal alternatives also be considered.

Wilson SM, Madel MJ, Mattson DJ, Graham JM, Burchfield JA, Belsky JM. 2005. Natural Landscape Features, Human-Related Attractants, and Conflict Hotspots: A Spatial Analysis of Human-Grizzly Bear Conflicts. *Ursus* 16(1):117-29.

There is a long history of conflict in the western United States between humans and grizzly bears involving agricultural attractants. However, little is known about the spatial dimensions of this conflict and the relative importance of different attractants. Wilson et al. investigated the spatial relationships of rivers and creeks, livestock pastures, boneyards (livestock carcass dumpsites), beehives, and grizzly bear habitat in conjunction with reported human-grizzly bear conflicts from 1986 to 2001, on the Eastern Rocky Mountain Front, in Montana. They used density surface mapping to identify seasonal clusters of conflicts that functioned as conflict hotspots.

Hotspot locations accounted for 75% of all conflicts while encompassing only 8% of the study area, and 10 chronic hotspots accounted for 58% of all conflicts. Conflicts were most strongly associated with rivers and creeks, followed by sheep lambing areas and fall sheep pastures. They also were associated with cattle calving areas, spring cow-calf pastures, summer and fall cattle pastures, and boneyards.

The majority of conflicts occurred in a small portion of the study area, where concentrations of attractants overlapped bear habitat; hotspots that could be targeted by management and conservation efforts that focus on removing or protecting attractants using non-lethal techniques. Most deaths of sub-adult and adult grizzlies in the study region are caused by humans. A disproportionate number of these deaths occurred on private lands as a result of conflicts precipitated by attractants.

Patterns of depredation along the Eastern Rocky Mountain Front seem to be deeply rooted in the natural foraging behavior of grizzly bears. Knowing about potential problem sites provides the opportunity to proactively ameliorate more serious conflicts before they start. Wilson et al. suggest that behaviors of individual bears alone cannot adequately explain the observed patterns of conflict and that most conflicts were more likely the result of problematic contexts.

Wilson SM, Madel MJ, Mattson DJ, Graham JM, Merrill T. 2006. Landscape Conditions Predisposing Grizzly Bears to Conflicts on Private Agricultural Lands in the Western USA. *Biological Conservation* 130:47-59.

In this follow-on study, Wilson et al. modeled the relationship between different landscape conditions and the likelihood of human-grizzly bear conflicts. Their focus was on private agricultural ranch lands along Montana's Rocky Mountain. They used locations of livestock pastures, livestock carcass disposal areas (boneyards), beehives, and wetland-riparian vegetation to model the locations of 178 human-grizzly conflicts between 1986 and 2001.

The authors found that most conflicts were associated with concentrations of attractants located within productive bear habitat. They also found a very strong link between spatial and temporal collections of attractants and the likelihood of human-grizzly conflict.

Wilson et al. argue that grizzly bear management and conservation efforts on private agricultural lands should focus on locations where attractants are concentrated in high-quality bear habitat. Identifying, predicting, and responding to conflicts may be systematically accomplished by prioritizing efforts in locations where the greatest number of attractants are found near to one another. The authors suggest non-lethal deterrent techniques such as electric fencing of beehives, calving areas, sheep bedding/lambing areas, and carcass removal. They note that this will require the active participation and collaboration of ranchers and landowners whose combined attractants are leading to chronic conflict situations.

Young JK, Ma Z, Laudati A, Berger J. 2015. Human-Carnivore Interactions: Lessons Learned from Communities in the American West. *Human Dimensions of Wildlife* 00:1-18. DOI:10.1080/10871209.2015.1016388.

Most strategies for addressing human-carnivore conflicts in rural areas have focused on mitigating economic loss. Such strategies, however, often fail to adequately account for changing and varied perceptions of those who directly interact with carnivores on a regular basis (Montag 2003). There remains a need to better understand how non-ecological factors, especially those beyond economics, shape human-carnivore conflicts and are linked to human-carnivore coexistence (Dickman et al. 2011, Inskip and Zimmerman 2009, Jacobson et al. 2012, Kellert et al. 1996).

Focusing on four rural communities in Idaho, Montana, and Washington, Young et al. conducted focus groups and interviews to assess the complexities of human-carnivore interactions and to determine factors influencing individual willingness to coexist with carnivores.

They found that: i) participants spoke more about socioeconomic and political factors than ecological ones; ii) desired actions that were articulated appeared to correlate with historical context; and iii), there seemed to be a link between a community's willingness to coexist and state management policies.

Young et al. suggest a need to better understand how different stakeholders interpret scientific information, what strategies can facilitate effective communication among stakeholders, and what makes stakeholders feel treated justly when human-carnivore conflicts occur.

Zajac RM, Bruskotter JT, Wilson RS, Prange S. 2012. Learning to Live with Black Bears: A Psychological Model of Acceptance. *Journal of Wildlife Management* 76(7):1331-40. DOI:10.1002/jwmg.398.

The recovery of large carnivores in human-dominated landscapes creates a need to understand how people will respond to the presence of these animals. Zajac et al. tested a psychological model of acceptance to determine what variables most influence people's acceptance for black bears in an area in Ohio with an emerging black bear population.

The authors hypothesized that people's perceptions of risk and benefit related to bears would mediate the effect of trust (in wildlife management agencies) and personal control (over interactions with and management of wildlife) on acceptance for black bears.

They found that interventions raising an individual's social trust in the managing agency, or personal control can indirectly raise stakeholders' acceptance by reducing risk perception and increasing perception of benefits from carnivores.

The authors suggest that, as large carnivore population expand and interactions with humans increase, these results could aid managers in designing outreach materials and communications aimed at promoting acceptance for large carnivores.

Zarco-Gonzalez, M., Monroy-Vilchis, O., Rodriguez-Soto, C., Urios, V. 2012. Spatial Factors and Management Associated with Livestock Predations by *Puma concolor* in Central Mexico. *Human Ecology* 40(4):631-38. DOI:10.1007/s10745-012-9505-4.

There have been numerous studies on the economic loss of predation on livestock, but few studies have been done that assess the relationships between livestock management practices and predations, and even fewer suggesting predation sites were associated with topographic feature. Zarco-Gonzalez et al. evaluated relationships between livestock predation risk and local topographical factors, and assessed livestock management practices in this region in central Mexico.

A previous study in the region indicated that livestock contributed only 8.2% of the relative biomass of puma prey, mainly remnants of cows and goats. This supports the conclusion that felids in this region kill fewer domestic animals than livestock holders believe. In all confirmed cases, puma was considered the responsible predator, which was supported by evidence found in more than half of the attacks. On the other hand, livestock holders identified this species in all sightings.

In addition, although most the domestic prey were adults, Zarco-Gonzalez et al. noted that livestock holders do not keep records of livestock births and commented that occasionally offspring disappear. It is likely that some of these losses are due to predations and that predation of young may occur more frequently than perceived. Free-range grazing also appeared to be more susceptible to predation. In the study zone most animals graze in large groups, often far from human settlement, which implies greater risk to pumas as group size is positively correlated with predation with groups less than 20 individuals most at risk. The lack of night shelter increases the livestock vulnerability in relation to the nocturnal habits of puma. Although the overall percentage of livestock loss by predation is relatively low, because these are marginalized communities the losses are considerable, and account for about 17% of the total value of livestock present in the sites of attacks.

The authors found a high percentage of losses were concentrated in a few sites, which are known as hotspots and a site effect. This study is one of the first to evaluate and to confirm this site effect through the influence of physiographic variables at the sites of attack. Zarco-Gonzalez et al. conclude that the importance of characterizing attack sites using predictive models allows focusing prevention efforts and mitigation measures in high-risk areas.