Chapter

CARNIVORES, CONFLICT, AND CONSERVATION: DEFINING THE LANDSCAPE OF CONFLICT

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ABSTRACT

Mitigating conflict between humans and large carnivores is one of the most pressing and intractable concerns in conservation. Yet, there has been surprisingly little effort devoted to incorporating risk assessments of conflict in carnivore conservation and land-use planning. Because human-carnivore conflict can have far-reaching societal and environmental impacts, attention to the 'conflict–conservation nexus' should become integrated into national and global environmental policy-making. However, *how* 'the nexus' is defined, elucidated, and ultimately utilized to forecast and mitigate conflict remains under-explored. Here, we discuss the limitations of current knowledge and methodologies available to forecast human–carnivore conflict and suggest a novel heuristic framework that integrates ecological and sociological data to better predict and mitigate conflict, and optimize conservation planning. We illustrate the utility of our approach using a case study of carnivore connectivity planning in the southwestern United States. Our approach holds promise as an effective tool for use in carnivore conservation by allowing decision-makers to prioritize planning efforts by integrating biological suitability, threat of conflict, and societal acceptance.

INTRODUCTION

Carnivores, particularly top predators, fill vital roles in ecosystems such as contributing to the maintenance of biodiversity (Dalerum et al. 2008), limiting the number of prey species, and functioning as conservation surrogates for less charismatic sensitive species (e.g., Dalerum et al. 2008). Throughout the world, maintaining many populations of large carnivores will require that animals exist in multi-use landscapes in which people are a component of, or the dominant feature on, the landscape. However, where humans and

carnivores coexist, competition for shared resources such as prey species or livestock often results in conflict (Thirgood et al. 2000, Sillero-Zubiri and Laurenson, 2001), which we define as a perceived negative interaction between humans and wildlife that results in the implementation of management to reduce the negative interactions. Conflict can have meaningful negative impacts to people and the management of conflict animals can be detrimental to conservation efforts. Indeed, anthropogenic factors including conflict with humans are the primary driver of global declines in several large carnivore species such as African lions (*Panthera leo*), tigers (*Panthera tigris*), and Mexican wolves (*Canis lupus baileyii*) (Michalski et al. 2006). Faced with these issues, resolving conflicts between people and predators is of fundamental importance to developing effective conservation strategies for large carnivores.

Human-wildlife conflict is distinct from typical biological parameters (e.g., animal behavior, population dynamics, or species richness) in that it is as much a sociological phenomenon as it is a biological phenomenon. Thus people with differing beliefs and attitudes towards wildlife and the actions of wildlife can influence the perception of what is or is not deemed conflict. For example, some cultures have greater tolerance for the presence of animals (e.g., Hindu) than others. Similarly, within a culture, some individual people have greater tolerance than others and we argue that understanding this dynamic is critical for implementing effective conservation policy.

If we accept the basic tenet that human-carnivore conflict is mediated by the competition for shared resources— be they space, prey, or domesticated animals— then, conceptually, it should be a relatively straightforward exercise to develop strategies to mitigate conflict. In essence, conflict prevention depends on (i) identifying ecological and social conditions that mediate interactions between wildlife and people (Treves et al. 2004), (ii) understanding how interactions can escalate into conflict, and (iii) developing effective outreach or intervention strategies to minimize the risk of future conflict. Ecologists and social scientists have been effective in identifying the ecological space where humans and wildlife are most likely to interact (e.g., Kretser et al. 2008, 2009) and what causes some interactions to escalate into conflict, but markedly less successful in integrating the two into forecasting tools. This of course leads to the question of do we really need to take an integrative approach to managing conflict? We suggest the answer to that question is yes— a holistic, integrative approach can be a powerful tool for managing the risk of conflict, particularly if the approach is spatially explicit to allow the prediction of when and where conflict is most likely to occur. However, in order to reach that goal, we first need to understand the limitations of current approaches.

The primary objective of this paper is to develop a framework for integrating ecological and sociological data for use in modeling the spatial distribution of the risk of human–carnivore conflict. The paper begins with a brief review of methods used to predict conflict. We then propose a novel approach for integrating ecological and sociological data into a predictive modeling framework. We illustrate this approach using a practical example based on conservation planning for black bears (*Ursus americanus*) in the southwestern United States.

ECOLOGICAL APPROACHES TO PREDICTING RISK OF CONFLICT

We define ecological approaches to predicting the risk of human-carnivore conflict as those solely based on ecological analyses of factors that influence the occurrence of conflict.

Generally, these approaches are spatially explicit and employ predictive modeling to correlate landscape attributes to the occurrence of conflict. The spatially explicit models are then often used to project the risk of conflict, given the composition and arrangement of landscape attributes, at a larger spatial scale. The value of this approach is threefold. First, the data are relatively easy to acquire. In the United States, most state agencies, and a few federal agencies (i.e., Wildlife Services, United States Fish and Wildlife Service), regularly collect geo-referenced reports of human-wildlife conflict, including damage, depredation, and adverse encounters. Second, remotely-sensed biophysical data are readily, and in most cases freely, available from a number of data aggregators and websites (e.g., United States Geological Survey Seamless Server). Third, the remotely-sensed data is typically updated on a regular basis. For example, the National Landcover Data Set, which provides information on land cover types in the United States, is updated at 5-yr intervals— this allows the predictive models to be easily updated as landscape composition and other attributes change.

Ecological approaches to predicting risk of human-carnivore conflict are common in the literature. For example, Michalski et al. (2006) used such an approach to predict felid–livestock conflict in Brazilian Amazonia. The authors examined the ecological correlates of jaguar (*Panthera onca*) and puma (*Felis concolor*) predation on livestock by interviewing livestock managers to collect information on the spatial distribution of depredation events. They then related the occurrence of jaguar and puma depredation to an array of remotely-sensed landscape attribute variables as well as livestock grazing practices. Using this approach, the authors found that patterns of depredation could be explained by a combination of landscape and livestock management variables such as proportion of forest area, distance to the nearest riparian corridor, annual calving peak and bovine herd size (Michalski et al. 2006). A similar approach was employed by Treves et al. (2004, 2011) to predict the risk of wolf (*Canis lupus*)–livestock conflict in the Upper Midwest of the United States. The authors used data on wolf-killed livestock collected by state wildlife agencies to compare landscape attributes between affected (suffered at least 1 depredation event) and unaffected (no depredations reported) sites to determine the spatial distribution of risk. Similar to Michalski et al. (2006), Treves et al. (2004, 2011) found that risk of depredation was a function of the juxtaposition of high quality wolf habitat with areas of intense livestock grazing.

These efforts illustrate the utility of using a biophysical approach in predicting the risk of human-carnivore conflict. The value of this approach lies in the relative simplicity of incorporating human land uses, carnivore biology, and land cover simultaneously (i.e., Treves et al. 2011). But distinctly missing from this approach is a measure of the sociological component of conflict, most notably the attitudes and perceptions of people. We maintain that integrating sociological data into the established ecological framework for predicting and modeling conflict could offer better conflict risk assessment.

Sociological Approaches to Predicting Risk of Conflict

Sociological research on wildlife conflict typically focuses on problem identification, formulation of mitigation strategies, and evaluation of the success of management actions (e.g., Ring 2008, Treves et al. 2006). For the latter two foci, identifying stakeholders and understanding their characteristics, values, attitudes, and acceptance of different management actions is critical. For example, a review by Vaske et al. (2006) revealed that most research published in *Human Dimensions of Wildlife,* a leading journal in the field, has focused on

attitudes, beliefs, values, norms, and satisfactions (62%), as compared with behavior-related research (18%). So how does an understanding of attitudes and beliefs help resolve human–wildlife conflict?

Much of the sociological research relies on the analysis of survey data collected from stakeholders designed to elicit information on relevant attitudes and perceptions. This information can then be correlated with stakeholder behaviors and, if correlations are strong, used to indirectly predict future behavior (Manfredo 2008). Of course, when correlations are weak, only direct measures of behavior will be effective (McCleery et al. 2006). Conceptually, this is not so different from limitations of ecologically-based predictors of conflict. However, unlike ecological data, sociological data generally are not as readily available nor spatially explicit. For example, sociological data are not regularly collected along with conflict data, so collection often requires a rigorously designed survey. Nevertheless, there is growing acknowledgement that there is a need to focus conflict management solutions on humans as well as wildlife (Baruch-Mordo et al. 2009, 2011).

Researchers have examined social and attitudinal variables that seemingly influence a range of perceptions about actual human–carnivore interactions. In general, they've found that perceptions of future interactions are related to past experiences. Not surprisingly, individuals with negative experiences typically have less tolerance for future conflict (Coluccy et al. 2001, Heberlien and Ericsson 2005). Tolerance is also informed by how individuals use land, be it for recreation, agricultural production, or resource extraction. For example, Kellert et al. (1996) found that perceptions of carnivores (including black bears) were more negative for people who worked in natural resources extractive industries or lived in rural areas (Kellert et al. 1996). By contrast, Kaczensky et al. (2004) found that positive perceptions of bears and wolves were related to higher levels of education and more knowledge about those species. Likewise, Siemer and Decker (2003) found that nearly 90% of reported bear encounters in New York were positive and people living in the core bear habitat, and arguably more knowledgeable about bears, were more tolerant of hypothetical interactions with bears around their homes compared to those living outside of the core habitat. What these disparate findings indicate is that the perception of risk by individuals is highly variable and can differ relative to education, predominant land use, and personal experience.

Defining the Landscape of Conflict

Both ecological and sociological approaches have been used successfully to predict the risk of human–carnivore conflict. However, limitations exist for each approach that potentially compromises their efficacy. To overcome these limitations, we propose a novel heuristic framework that integrates ecological and sociological data to better predict and mitigate human–carnivore conflict. We elucidate this concept using an example focused on conservation planning for black bears in the southwestern United States. In the Southwest, black bears are near the southern extent of their geographic range and subpopulations are vulnerable to isolation and localized extinction (Atwood et al. 2011). Black bears also come into conflict with humans, particularly during years of hard mast failure (LeCount 1982, Baruch-Mordo et al. 2008). Because of this, bears in the region can be viewed as existing at the conservation–conflict nexus, where conservation planning and conflict mitigation should

intersect. Our approach, will use spatially explicit modeling to illustrate the landscape of conflict— a landscape where animals interact simultaneously within an ecological and sociological landscape. We will use these interactions determine the spatial distribution of risk of conflict.
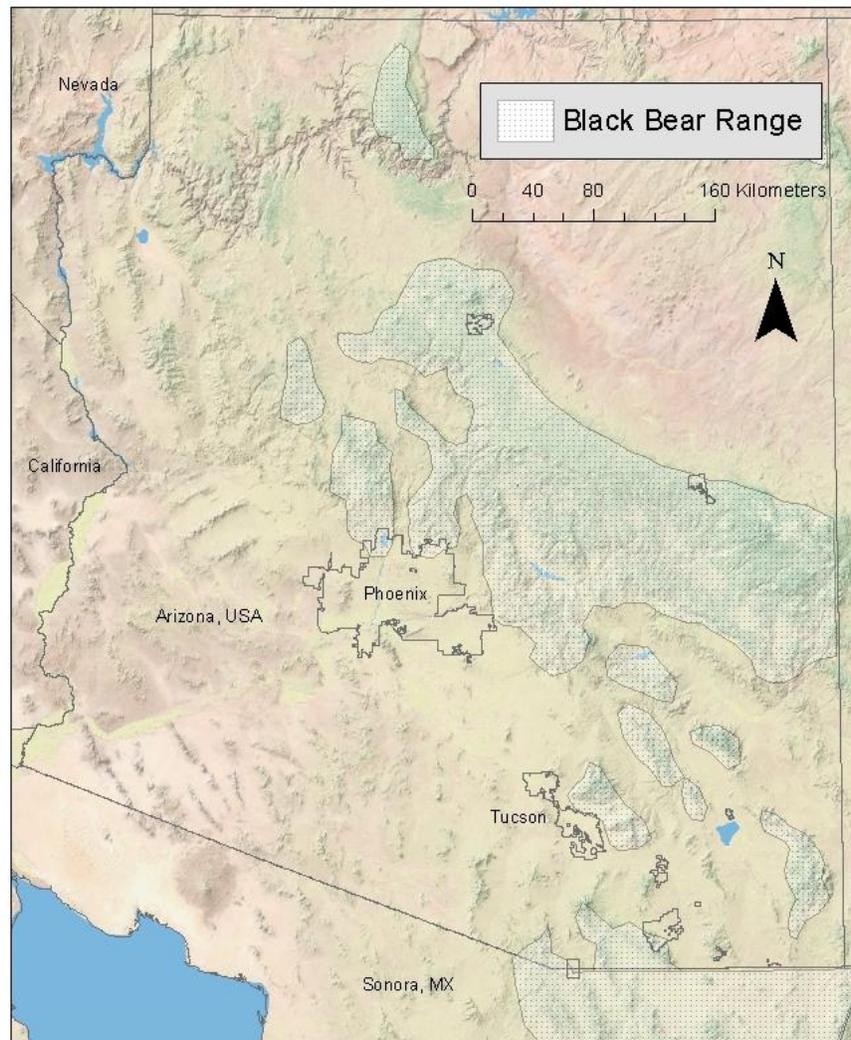

Figure 1. Black bear range in Arizona and the study area for investigating the utility of integrating ecological and human dimensions data for predicting risk of human-bear conflict.

STUDY AREA

We sampled the occurrence of black bears in the Patagonia, Huachuca, and Santa Rita mountains in southern Arizona (Figure 1). The three mountain ranges are adjacent to each other; the Santa Rita Mountains are the northernmost, while the Patagonia and Huachuca mountains extend approximately 31 km and 4 km, respectively, into Sonora, Mexico. In Sonora, the Patagonia Mountains are separated by 7 km of desert basin from the northern

extent of the large (≈5396 km^2) Sierra Mariquita- Sierra de los Ajos mountain range complex. As a result, the Patagonia and Huachuca mountains likely play an important role in maintaining trans-border connectivity between Arizona and Sonora, which is important because black bears in Mexico were classified as "endangered of extinction" in 1986. We projected the findings of our predictive models to the Tumacacori Highlands, and the Dragoon and Whetstone mountains, in addition to the sampled mountain ranges.

Vegetation in the study area consisted of shrub and grassland associations at lower elevations, oak woodlands at mid-elevations, and Madrean evergreen woodlands at higher elevations (Brown, 1994; Bahre and Minnich, 2001). Predominant land use included livestock grazing and recreation. The area has experienced rapid urbanization over the last 20 years, characterized by a ≈20% increase in the human population and a ≈14% increase in housing density (http://quickfacts.census.gov/qfd/states/04000.html). The international boundary between Arizona and Sonora, Mexico, spans nearly 600 km, approximately 70% of which was fenced. The type of fence structure varied along the border (Figure 2 and 3), with some segments comprised of >4 m tall panels with either no openings or vertical gaps 5–10 cm wide and thus impermeable to most medium- and large-bodied mammals, while other sections consisted of barbed wire crossbar vehicle barriers (United States Customs and Border Protection, 2009) that were relatively permeable.

METHODS

Extensive details on our sampling methodology are available in Atwood et al. (2011). Briefly, we used non-invasive hair-snag corrals (Woods et al. 1999) deployed within 4 × 4 km grid cells to collect hair samples from black bears. Hair snag grids were deployed over three 10-14 day "capture" sessions in all 3 mountain ranges in the spring and summers of 2008 and 2009. Samples were retrieved from hair snags and submitted for genetic analyses to confirm species and determine individual identification. We used point extraction and Euclidean distance routines in a 30-m resolution (i.e., 2006 USGS Seamless Server NED data) GIS to collect information on land cover and landscape covariates for hair-snag locations. We tested for collinearity among potential variables by examining tolerance and variance inflation factors (VIF) using weighted least squares regression, and excluded variables with tolerance scores <0.4 from analyses (Allison, 1999). We then used the data generated from hair-snag sampling in program MARK (White and Burnham, 1999) to develop models of black bear occupancy relative to land cover (Madrean evergreen woodland [MEW], mixed conifer woodland [MXC], semi-desert grassland [DG], plains and Great Basin grassland [GBG], and oak woodland [OW]) and landscape covariates (slope [◦], aspect, elevation [m], and distances to permanent water and roads [m]).
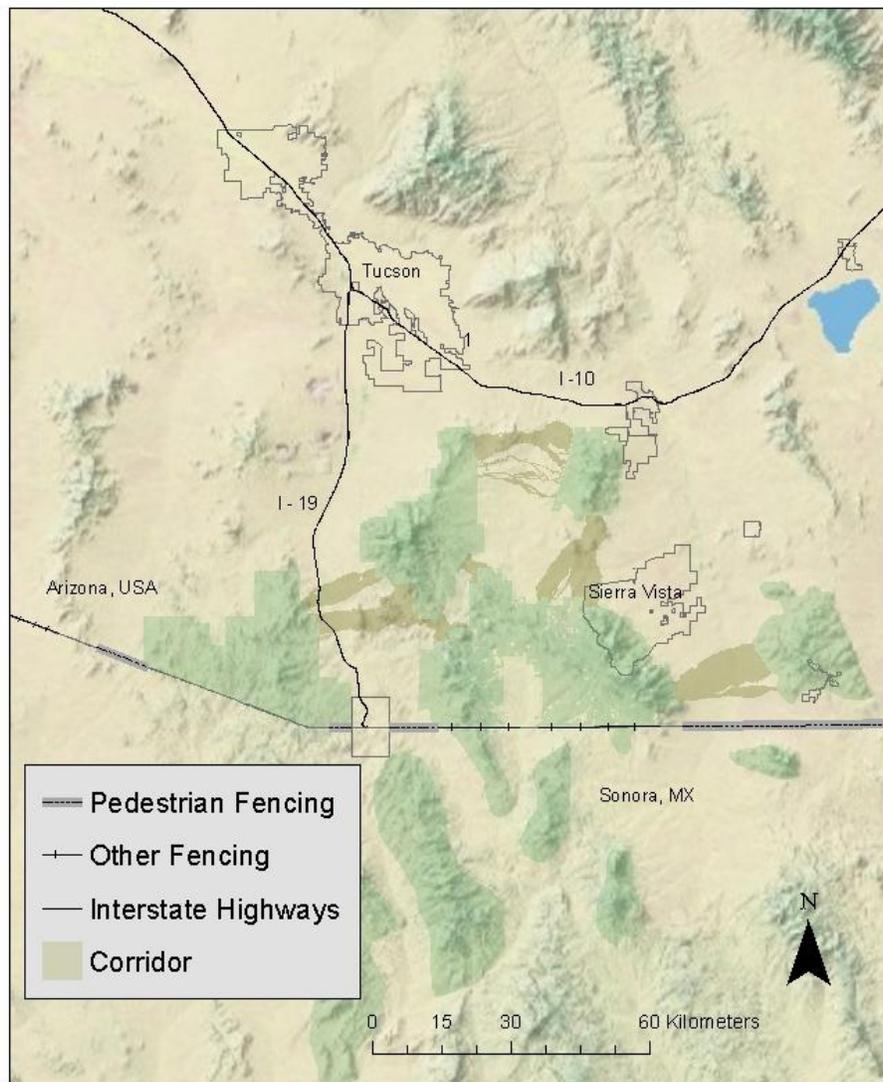
Figure 2. Corridor linkage created using the ecologically-based habitat suitability model and corresponding cost surface.

To frame this work in a conservation context, we used the habitat suitability and corridor models (i.e., ecological models) created by Atwood et al. (2011) to describe how bears used the landscape in the study area and moved between mountain ranges via movement corridors. We then integrated the simulated sociological data (described below) into the base models to develop the ecological-sociological models to project how negative human attitudes could affect habitat suitability and landscape connectivity.

Table 1. Grid layers (italics) and variables, reclassified grid cell values, and weighting factors used to assemble the ecologically-based and ecological-sociological habitat suitability models for the study area

Variable	Reclassified Cell Value	Weighting Factor Ecological Model	Weighting Factor Integrated Model
Landcover type		0.50	0.40
Madrean evergreen	100		
mixed conifer	68		
oak woodland	84		
semi-desert grassland	56		
Plains and Great Basin Grassland	1		
Distance to Water		0.35	0.30
<500m	25		
500-1000m	50		
>1000m	100		
Distance to Roads		0.05	0.04
>500m	25		
500-1250m	50		
>1250m	100		
Aspect		0.04	0.03
north	80		
east	35		
south	100		
west	25		
Elevation		0.03	0.02
>763m	20		
763-1219m	37		
1220-1981m	100		
1982-2591m	81		
2592-4000m	63		
Topographic Position		0.03	0.02
canyon bottom	50		
gentle slope	100		
ridge top	25		
Human Tolerance		not applicable	0.19
yes	100		
no	0		

Habitat and Corridor Modeling

We used the model-averaged occupancy values reported in Atwood et al. (2011) to create habitat suitability and corridor models. To develop the ecologically-based habitat suitability model (HSM), we reclassified the land cover grid by collapsing 35 landcover classes from the 2001 National Landcover Data (NLCD) set (e.g., Encinal oak woodland) into the land cover classes described above (e.g., MEW, MXC, DG, GBG, and OW), and assigned them a value from 0 (absolute non-habitat) to 100 (optimal habitat) based on detection probabilities scaled from occupancy models (Table 1). For the elevation, aspect, and distances to water and roads

grids, we created 5, 4, 3, and 3 evenly-spaced bins, respectively, and assigned values (0–100) based on probabilities of occurrence at hair-snag stations (Table 1). To characterize topographic position, we used a moving window analysis in a GIS where we classified pixels as canyon bottom if the pixel elevation was at least 12 m less than the neighborhood average, a ridge-top if the pixel elevation was at least 12 m greater than the neighborhood average, a gentle slope if the pixel was neither a canyon bottom nor a ridge-top and had a slope $<6°$, and a steep slope if the pixel was neither a canyon bottom nor a ridge-top and had a slope $>6°$. The resulting topographic position index (TPI) grid was then reclassified using the method for the elevation grid but into three bins instead of 5. Finally, we combined the six individual grids using a weighted geometric mean algorithm (Table 1) where individual grid weighting factors were scaled to their proportional contribution based on the model-averaged Akaike weights.

For the integrated ecological-sociological modeling effort, we simulated human dimensions data by randomly assigning 1000 residential addresses in the study area pixel value scores of 0 (i.e., pixel is occupied by a person intolerant of large carnivores) or 100 (i.e., pixel is occupied by a person tolerant of large carnivores). We then used a moving window analysis (2×2 km window), similar to that used to characterize topographic position, to reclassify all pixels within the window to the same value as the focal pixel. We did this for 2 reasons. First, social scientists have documented a "neighborhood effect", where the magnitude of a decision or attitude for an agent (i.e., person) depends on the magnitudes of the decision or attitudes for neighboring agents (i.e., a community). In the context of human–carnivore conflict, a person with an a priori high tolerance for carnivores may lower their tolerance threshold if their neighbors have either a high vulnerability or low tolerance of conflict (Kretser et al. 2008). Second, much of the area is used for livestock grazing and the lower size limit of allotments and pastures is 4 km^2. What this effort gave us was a spatially explicit layer of human attitudes, which we then combined with the 6 other individual grids using the same procedure for the ecologically-based HSM (Table 1).

To develop the corridor models, we converted the HSM (baseline and second run) into cost surfaces by calculating cell resistance (i.e., travel cost; cell resistance $= 100 -$ pixel suitability) for each grid. The resulting cost surface grids were comprised of pixel values that reflected the cost of (or resistance to) movement through each individual grid cell, with increasing cell values representing increasing resistance to movement. We then applied a moving window analysis (200-m radius) to generate corridor models (pixel swaths; Atwood et al. 2011) that connected habitat cores while minimizing resistance to movement. We selected the best biological corridors (e.g., Bennett et al., 1994) based on the pixel swath that minimized within-swath gaps, maximized within-swath habitat suitability, and reduced edge effects by maintaining a minimum width equal to the radius of an estimated home range (LeCount 1982, Cunningham and Ballard 2004). All habitat and corridor modeling was done using the CorridorDesigner package for ArcGIS (Majka et al. 2007). To characterize the landscape of conflict, and examine how negative human attitudes influenced the distribution of conflict, we compared the spatial attributes of our ecological model predicting corridors with our socio-ecological model that also included the simulated sociological data. This provided insight into how adverse attitudes towards black bears could potentially impact conservation planning.

RESULTS

The ecologically-based habitat suitability model characterized 33% of the study area as relatively high quality habitat (≥60 suitability quantile). This habitat occurred mostly in the focal mountain ranges, so we used those as wildland blocks to connect via the corridor models. The integrated ecological-sociological suitability model characterized 24% of the study area as high quality habitat, most of which occurred in the focal mountain ranges. A comparison of the two HSM indicated that for the integrated model, habitat suitability in the Huachuca Mountains declined by 5%, followed by 3% and 1% declines in the Patagonia and Santa Rita mountains, respectively. Habitat quality also declined in the Tumacacori Highlands, and Dragoon and Whetstone mountains, but the declines were negligible (i.e., <1%). All of the declines in habitat suitability occurred in mid-elevation oak woodland habitat, which functioned as critical foraging habitat for black bears (LeCount 1982).

The ecologically-based cost surface yielded relatively high quality corridors (Figure 2). The length to narrowest width ratios for the corridors linking the mountain ranges was 6.8:1 (range: 1.2:1–12.1:1; SE = 1.11), with the highest quality corridor linking the Santa Rita Mountains and the Huachuca-Patagonia complex, followed by the corridors linking the Huachuca-Patagonia complex to the Dragoon Mountains, Whetstone Mountains, and the Tumacacori Highlands, and the Santa Rita Mountains to the Whetstone Mountains, respectively. All of these corridors contained >57% suitable habitat. By contrast, the integrated ecological-sociological based cost surface yielded substantially lower quality corridors (Figure 3), with length to narrowest width ratios averaging 47:1 (range: 13.2:1–102.1:1; SE = 4.11), and the highest quality corridor linking the Santa Rita Mountains and the Huachuca-Patagonia complex, followed by corridors linking the Huachuca-Patagonia complex to the Tumacacori Highlands, Dragoon Mountains, the Santa Rita Mountains to the Whetstone Mountains, and Huachuca-Patagonia complex to the Whetstone Mountains, respectively. All of these corridors contained <21% suitable habitat, rendering them biologically degraded compared to the corridors estimated from the ecologically-based cost surface.

DISCUSSION

Our study revealed important findings about the potential utility of integrating ecological and sociological data for use in predicting the spatial distribution of risk of conflict. First, if collected at the appropriate spatial scale (e.g., parcel ownership), it is relatively straightforward to create a spatially explicit projection of attitudes and perceptions. We demonstrated this using a novel approach where we integrated the simulated survey data on tolerance of large carnivores into habitat suitability and cost surface models. Second, our approach has heuristic value in the context of conservation planning, because it can be used to project how human attitudes and perceptions might be spatially distributed across a landscape. Third, and arguably most important, by integrating a simulated spatial layer into the HSM representing human tolerance towards large carnivores, we were able to depict how low tolerance of carnivores can potentially degrade the functional quality of otherwise highly suitable movement corridors. Given the above, we believe our approach has merit for future

research and guiding efforts aimed at mitigating risk of human-carnivore conflict, particularly if used at the conservation planning stage.
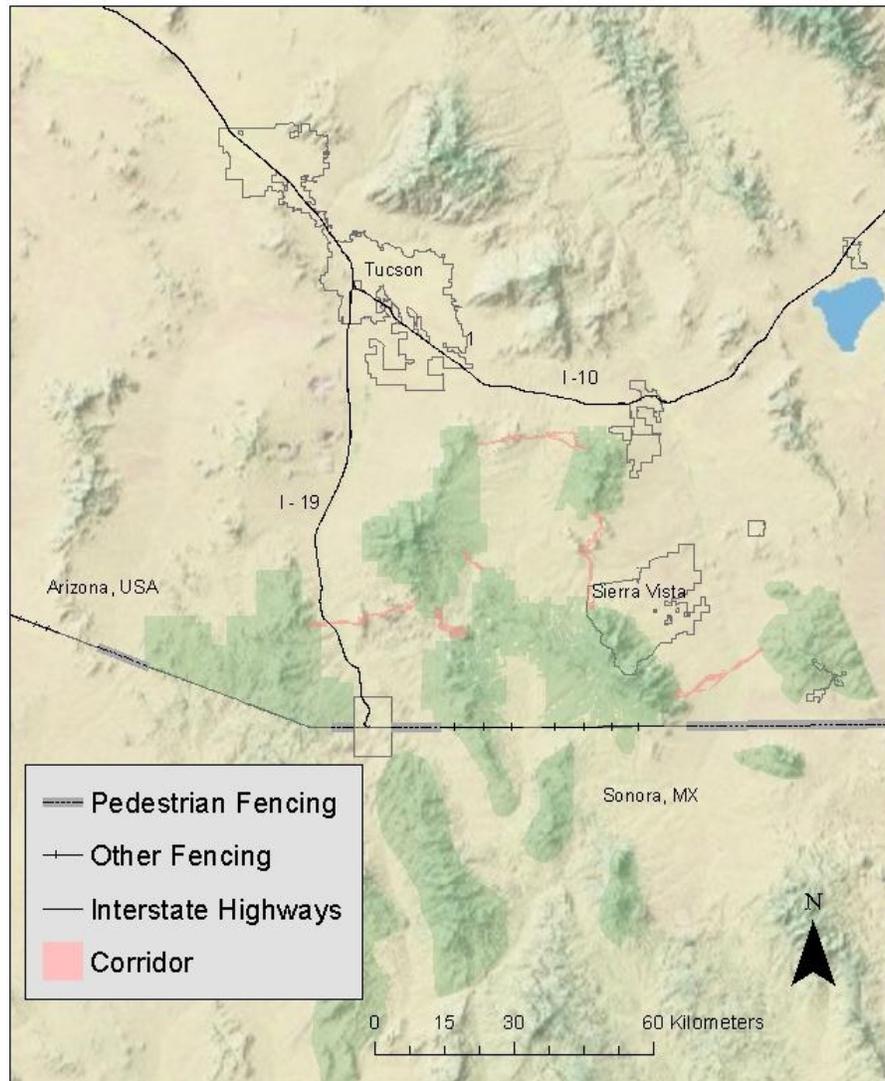
Figure 3. Corridor linkage created using the integrated ecological-human dimensions habitat suitability model and corresponding cost surface.

The ecological determinants of conflict tend to operate at a fine scale, whereas trends in human attitudes are typically only made available at a more coarse scale. The mismatch of the spatial scales at which the two processes occur has been a fundamental impediment to the integration of ecological and sociological data. As ecologists know well, no question framed in a spatial context can be addressed without explicitly identifying the resolution at which observations are collected or projected. Indeed, patterns observed on one scale may not be apparent on another scale (Guisan and Thuiller 2005), so acknowledging that scale influences the nature, distribution, and interpretation of interactions between those processes is critical

(Cumming et al. 2006). That said, issues of privacy often preclude reporting fine-scale sociological data, and that has limited the efficacy of previous attempts to integrate sociological and ecological data. The approach we employed, using simulated sociological data, was a viable alternative for reconciling the concern over reporting sensitive information while still displaying the data at a meaningful spatial scale. Using a moving window analysis that explicitly incorporated a neighborhood effect, we were able to use individual point location data to project to a neighborhood scale and thereby avoid concerns over displaying spatially identifiable personal information.

Integrating ecological and sociological data in a spatial modeling framework has myriad applications. We demonstrated the heuristic value of using the framework to address an applied conservation issue centered on reconciling connectivity planning with conflict mitigation. Conservation strategies for at-risk species have been developed using models of varying complexities, including population models (e.g. population viability analyses), landscape models (e.g. resource selection functions), and spatially explicit dynamic models [e.g. spatially explicit, individual-based model (SE-IBM)] (Shenk and Franklin 2001, Wiegand et al. 2004), but we are unaware of any spatially explicit ecological models that also include sociological data. For large carnivores distributed in small subpopulations, such as desert black bears, the main factors causing localized extinction are loss or conversion of their habitat and increased illegal killing by humans in response to conflict (Ferreras et al. 2001). Obviously, both create controversies and challenges for the conservation of large carnivores. Black bears, for example, come into conflict with humans mainly through competition over food resources, primarily crops and refuse, but also occasionally neonatal livestock (Baruch-Mordo et al. 2008, LeCount 1982). Hence, there are often competing pressures on wildlife managers to mitigate conflict while also maintaining viable populations. What is clearly needed then, is a tool that allows wildlife managers and land use planners to identify areas of high biological suitability that occur in proximity to areas of high human tolerance. This information can then be used to prioritize mitigation efforts appropriately, while also minimizing the ecological and economic costs of trial and error for at-risk species. We believe our integrated modeling approach holds promise in that regard.

Ecological factors are the primary drivers of the spatial distribution of high quality habitat and movement corridors. However, it is important to note that when high quality habitat and corridors occur in areas occupied by intolerant humans, illegal killing or harassment can functionally degrade the conservation value of those areas. Our modeling efforts support that it is important to know the spatial distribution of tolerance before extensive resources are invested into implementing conservation plans such as purchasing tracts of land or entering into easement agreements. When we integrated the sociological layer into the ecological HSM and subsequent cost grid, we saw a marked decrease in the quality of movement corridors, such that the length:width of corridors increased 7-fold. The result of this is long, narrow corridors that contain less suitable habitat and restrict movement between wildland blocks to a fine corridor swath. Large carnivores, in general, have large area requirements— even when using movement corridors. As a result, corridors that become too narrow no longer offer refugia from humans or sympatric carnivores, and thus lose their biological integrity (Beier et al. 2008, Chetkiewicz and Boyce 2009). From a conservation planning perspective, it is vitally important to be able to predict where on the landscape habitat suitability is likely to interact with human attitudes to determine functional habitat

suitability. That information can then be used to not only identify the best biological habitat and corridors, but also the most socially acceptable.

The dearth of economic resources available to conserve or recover carnivore populations necessitates the development or refinement of methods to identify conservation priorities (Margules and Pressey 2000). Our integrated approach represents a novel and useful tool for the conservation planner's toolbox. By developing a spatially explicit modeling approach that integrates ecological and sociological data, we created a predictive modeling framework that is flexible to changes in attitudes and landscape characteristics, avoids concerns over the disclosure of sensitive private information, and allows users to balance biological and societal concerns when setting planning priorities. The information we present here, if incorporated into carnivore management plans, may also aid in ameliorating the adverse effects of conflict with humans, which is critical to the long-term societal acceptance of large carnivores on the landscape.

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