A GPS-collared cougar in west-central Alberta

University of Alberta

Conserving Cougars in a Rural Landscape: Habitat Requirements and Local Tolerance in West-Central Alberta

by

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ABSTRACT

Maintaining large carnivores in human-dominated landscapes poses a significant conservation challenge. Extirpation is common because of habitat loss or direct persecution. I studied cougar habitat selection and human perception of cougars in west-central Alberta to better understand human-cougar coexistence. Cougars that were exposed to higher levels of development at the home-range scale exhibited less avoidance of anthropogenic features and altered habitat use temporally to accommodate variation in human activity, indicating behavioral resilience to development. Survey results showed that cougars were valued and tolerated by people, provided cougars did not occur near residences. Where human densities are increasing in moderately developed landscapes in west-central Alberta, therefore, human tolerance may currently be more important than habitat change for conserving cougar populations. Tolerance was negatively affected primarily by the risk (real and perceived) cougars pose to people, livestock, and game. Public education to counteract overestimation of risk may increase tolerance.

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CHAPTER 1
GENERAL INTRODUCTION

Will large carnivores be relegated to dwindling reserves of pristine wilderness or can they persist in human-dominated landscapes? The answer to this question depends on two factors: (1) the resilience of large carnivores to anthropogenic landscape change (Weaver et al. 1996), and (2) whether human populations are willing to coexist with predators that sometimes threaten their lives and livelihoods (Woodroffe et al. 2005). Providing data to answer these questions and developing management prescriptions with that knowledge in hand is an important component of large-carnivore conservation in an increasingly anthropogenic world.

Throughout this thesis, resilience is defined as the ability of a species to withstand or adapt to anthropogenic disturbance (i.e., landscape change or increasing human presence; Weaver et al. 1996). Species with low resilience will be unable to persist in modified landscapes, while those with high resilience may thrive. Large carnivores are frequently described as having low resilience (Weaver et al. 1996, Woodroffe 2000), but this is a broad generalization and variation among species appears to be high (Cardillo et al. 2004). Effective management and conservation of a particular species may therefore depend on understanding the degree to which that species is resilient to anthropogenic landscape change. Understanding the habitat requirements of carnivores will be critical for linking habitat patches (Chetkiewicz and Boyce 2009), planning development (Beier et al. 2006), and mitigating conflict (Treves et al. 2004).

For species that are resilient to anthropogenic habitat modification, the willingness of human populations to coexist with large carnivores (i.e., tolerance) may be the central factor influencing conservation prospects. Low tolerance in western societies has led to widespread extirpation of large carnivores in the past, but tolerance has increased in recent decades (Kellert et al 1996, Williams et al. 2002). In North America, for instance, wolves (*Canis lupus*), grizzly bears (*Ursus arctos*), and cougars (*Puma concolor*) are valued as much for their aesthetic beauty as their ecosystem function, and images of carnivores are frequently used by conservation organizations to drum up romantic support for conservation of wildlife and wilderness. Positive perceptions of large carnivores, however, are not shared by all. Rural communities often harbor deep-seeded resentment toward carnivores (Breitenmoser 1998) and are unwilling to support resurgence of previously extirpated populations.

In North America, cougars present an ideal species to explore the importance of habitat loss and human tolerance for conservation. Although they suffered dramatic range constrictions and population reduction following European settlement, cougar populations stabilized where they persisted in western North America with the refinement of management practices in the 1960’s and 1970’s. Today, breeding populations in the Cypress Hills of Alberta and Black Hills of South Dakota indicate that the species is repopulating portions of its former range (Anderson et al. 2009). Concurrent with increasing cougar populations has been a rise in the number of people and anthropogenic land use in western North America. Thus, cougars and people are increasingly using the same space. Habitat loss has been identified as the top threat to cougar conservation (Logan and Sweanor 2001), but the ability of cougars to persist in anthropogenic landscapes is poorly understood. Moreover, populations in some western states may be decreasing, not because of insufficient habitat but because of management actions taken in response to low tolerance for coexistence (Lambert et al. 2006).

Understanding both cougar habitat requirements in anthropogenic landscapes and the factors that will promote local human populations to tolerate cougars in their midst will therefore be critical to the conservation of the species. It is these two aspects of cougar conservation that I attempt to address in this thesis. To accomplish this goal, I studied a population of cougars in west-central Alberta inhabiting the Clearwater County, an area with a gradient of development ranging from wilderness parks to rural farmland, towns and acreages. I present my findings in this thesis in the form of two independent but interrelated papers. In addition to this introductory chapter and a summary chapter, the thesis contains two data chapters, which address the two key aspects of cougar conservation outlined above (i.e., habitat loss and tolerance).

In Chapter 2, I used location data collected from 41 GPS-collared cougars to investigate cougar habitat selection patterns. To determine how cougars might adapt to anthropogenic development, I modeled selection at the individual level and looked for the occurrence of functional responses in selection as development increased across the landscape as well as a temporal response of cougars to human activity. In Chapter 3, I used opinion data collected from a questionnaire delivered to residents of Clearwater County, Alberta to investigate what factors (i.e. value for cougars, risk perception, socio-economic information, proximity to cougars) influenced tolerance for cougars amongst a rural population that is currently coexisting with the large carnivore. Taken together these chapters aim to evaluate possibilities for cougar conservation and human-cougar coexistence as Alberta's population grows and its landscapes are increasingly affected by anthropogenic development, and I summarize these possibilities in Chapter 4.

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CHAPTER 2

COUGAR HABITAT SELECTION IN A RAPIDLY DEVELOPING LANDSCAPE

INTRODUCTION

Anthropogenic habitat modification and increased human presence on landscapes can negatively affect conservation prospects for a variety of species by altering habitat selection (Gill et al. 1996), creating ecological traps (Delibes et al. 2001), degrading habitat quality (Saunders et al. 1991), and reducing landscape level connectivity (Chetkiewicz et al. 2006). Populations of large terrestrial carnivores are thought to be especially susceptible to local and regional extirpation either directly when they are removed due to conflict (Woodroffe and Ginsberg 1998, Woodroffe 2000) or indirectly when habitats are altered and prey populations reduced (Noss et al. 1996, Fuller and Sievert 2001, Sunquist and Sunquist 2001, Karanth et al. 2004). Human populations continue to grow rapidly, and anthropogenic habitat change is occurring at an unprecedented pace and scale on global landscapes (Vitousek et al. 1997); thus effective large carnivore conservation may depend on landscape-level strategies capable of preserving sufficient habitat in the face of increasing demands by people for resources and space (Beier et al. 2006, Kareiva et al. 2007).

A fundamental step toward developing landscape-level conservation strategies for large carnivores is to understand what constitutes sufficient habitat in modified landscapes, but critical information is often lacking. In North America, for example, cougar (*Puma concolor*) populations are recovering and expanding their range after centuries of persecution (Anderson et al. 2009, Knopff 2010). However, core cougar range in the west is being transformed from lightly developed wilderness and rangelands to more intensively used rural and exurban landscapes (Logan and Sweanor 2001, Cougar Management Guidelines Working Group 2005, Sweanor and Logan 2009). Although habitat alteration has been identified as the single greatest threat to cougar conservation (Logan and Sweanor 2001), the extent to which cougars can use modified landscapes remains unclear. Cougar persistence in modified landscapes will depend on their resilience, i.e., their ability to withstand or adapt to disturbance (Weaver et al. 1996).

Behavioural flexibility, particularly the ability to alter habitat-use patterns, is a key attribute of resilient species (Woodroffe 2000, Boydston et al. 2003), and species that exhibit such flexibility have much better conservation prospects than those that do not (Weaver et al. 1996). Animals exhibit behavioural flexibility with respect to habitat in two primary ways: 1) temporal changes in habitat-use patterns, and 2) functional responses in habitat selection. Animals capable of modifying habitat selection temporally may be able to continue using anthropogenic landscapes by accessing them nocturnally, when humans are less active (Boydson et al. 2003, Hebblewhite and Merrill 2008). Functional responses in habitat selection occur when selection patterns change with changing availability (Mysterud and Ims 1998). Although rarely applied in the context of anthropogenic landscape modification, functional responses could have profound implications for conservation planning. Species that avoid disturbance less as it becomes increasingly abundant exhibit resilience, whereas species that avoid disturbance more as landscapes are developed are more vulnerable to extirpation.

To gain a better understanding of cougar resilience to anthropogenic landscape modification, I explored cougar habitat selection in a rapidly developing landscape in west-central Alberta, Canada. My objectives were to 1) develop a cougar habitat-selection model with a specific focus on determining the importance of anthropogenic features as drivers of habitat selection, 2) examine spatio-temporal changes in habitat selection and assess the degree of flexibility in cougar habitat selection, and 3) investigate cougar habitat selection across a gradient of anthropogenic disturbance to assess functional responses in habitat selection.

METHODS

Study area

I studied cougar habitat selection in a 16,900 km^2 study area located in the boreal foothills and mountains of west-central Alberta. The study area was selected because it contained a gradient of development and human use, providing the foundation for a natural experiment to assess cougar habitat selection with respect to anthropogenic landscape modification. Intensity of human development was highest in the eastern portion of the study area, which consisted almost entirely of private lands and included the towns of Rocky Mountain House (population 7,231) and Caroline (population 515), as well as rural farmland and small acreages. The human population has increased steadily in the eastern portion of the study area (2.79% annually during 2001-2006; Statistics Canada 2006). Road and building density on private land in the eastern portion of the study area (average density roads: 0.79km/km^2, buildings: 3.09/km^2) was substantially higher than on public land in the west (average density roads: 0.34km/km^2, buildings: 0.24/km^2; Figure 2.1). Industrial activity, primarily forestry and natural gas extraction, was common throughout much of the study area and contributed to an extensive network of roads, seismic lines, and pipelines. All forms of anthropogenic development decreased across an east-west gradient, reaching nil in portions of the Bighorn Backcountry, which abuts Banff and Jasper National Parks at the western edge of the study area (Figure 2.1).

The cougar population in the region is supported primarily by white-tailed deer (*Odocoileus virginianus*), but cougars also consumed mule deer (*O. hemionus*), elk (*Cervus elaphus*), moose (*Alces alces*), feral horses (*Equus caballus*), bighorn sheep (*Ovis canadensis*) and a variety of non-ungulate prey (Knopff et al. 2010b). Cougar numbers increased by at least 250% in my study area between 1991 and 2006 (Knopff 2010), although a combination of shooting and incidental snaring at wolf bait stations might have been sufficient to arrest or reverse this trend during 2006-2008 (Knopff et al. 2010a). Cougars were hunted on a quota basis (Ross et al. 1996), could be shot on sight on private land, and were occasionally killed or translocated as problem wildlife by Fish and Wildlife agency personnel. For information on the biophysical attributes of the study area see Knopff et al. 2009.

GPS telemetry data

I obtained information on cougar use of the landscape from global positioning system (GPS) telemetry collars deployed on cougars throughout the study area. A total of 41 cougars outfitted with Lotek 4400S GPS radiocollars (Lotek Engineering, Newmarket, Ontario, Canada) programmed to collect location data every 3 hours were used. All capture and handling procedures were approved by the University of Alberta Animal Care Committee Protocol No. 479505 and Province of Alberta Collection and Research Permit 19872 CN (see Knopff et al. 2009 for additional detail on captures). While collars were active, field crews attempted to locate each cougar once per week and download GPS data fortnightly. Cougars were monitored between 24 and 650 days ($\bar{x}$ = 192). Monitoring durations of less than one year occurred because of collar failure (n = 7 confirmed failures), cougar mortality (n = 17), or dispersal outside the study area (n = 1).

GIS layers

I classified habitats using the 25m-resolution Canadian Forest Service Earth Observation for Sustainable Development of Forest (EOSD; Natural Resources Canada 2009), updated annually for the study area with cut-block information (provided by Sundre Forest Products). I grouped habitat information into eight habitat types: open (i.e., grassland and non-vegetated habitat), shrub, wetland (i.e., wetland treed, wetland shrub, and wetland grassland), closed conifer, open conifer, deciduous forest, and mixed forest. Forest edge is considered an important component of cougar habitat (Holmes and Laundré 2006) and I calculated a forest edge layer by buffering the intersection of forest and all other habitat types by 60m. Similarly, forest is considered to be important for cougars in many places (Logan and Irwin 1985) and I developed a core forest layer by combining all forest types, subtracting edge, and depicting the amount of forest within a 500m radius moving window around each pixel. I also assigned scores for aspect and terrain ruggedness to each pixel based on a digital elevation model (DEM). Aspect was restricted to a binary variable identifying south-facing slopes (135º - 225º). Terrain ruggedness was estimated using a 500m radius moving window around each pixel with the Terrain Ruggedness Index (TRI) extension in Arc GIS 9.3 (Riley et al. 1999).

Layers for roads, pipelines, seismic lines, and oil and gas well locations were provided by Alberta Sustainable Resource Development. I developed a building layer by digitizing building locations from 5m-resolution satellite imagery taken in 2007. A *post-hoc* analysis showed that I successfully identified 98% of 328 homes drawn randomly from the phone book, indicating that I had excellent success identifying buildings from satellite imagery. To assess anthropogenic disturbance for each pixel, I calculated building density (no./km^2), road density (km/ km^2), pipeline (km/ km^2), seismic (km/ km^2), and well-site density (no./km^2) using a 500m moving window, and calculated Euclidian distances from each pixel to the nearest road and building.

Cougar Habitat Selection

RSF modeling

To identify key habitat characteristics influencing cougar habitat selection, I used resource selection functions (RSF) of the exponential form:

$$w(x) = \exp(\beta_1 x_1 + \beta_2 x_2 \cdots \beta_k x_k) \qquad \text{Equation 1}$$

where $w(x)$ is the RSF, x_i are the predictor variables, and β_i are the corresponding coefficients estimated using logistic regression software.

Resource selection functions are a robust tool for estimating the relative probability of selection by animals (Johnson et al. 2006). Variation in habitat selection patterns among individuals can be important, and is not accounted for in traditional population-level RSF models (Gilles et al. 2006). A simple solution to this shortfall is to model selection at the individual level, obtaining a population model by averaging coefficient scores across individuals (i.e., a 2-step modeling approach; Fieberg et al. 2010). I applied this 2-step approach to my cougar data under a use-available design (Johnson et al. 2006) at the home range scale (i.e., Johnson's 1980 3rd order selection).

Because I was interested in temporal patterns of habitat selection (see below), and because cougars in west-central Alberta remained with their kills continuously until they were consumed (i.e., habitat selection is constrained while the cougar feeds; Knopff et al. 2009), I separated locations when cougars were handling prey from other locations. This was possible because field crews visited most GPS location clusters and identified nearly all prey >8kg consumed by cougars (Knopff et al. 2010a, Knopff et al. 2010b). For model development, I defined cougar use locations (1) as the GPS locations obtained while cougars were not handling prey and generated available location points (0) at a density of 3/km^2 within each cougar's 100% minimum convex polygon (MCP) home range using Hawth's Analysis Tools Random Location Generator in Arc GIS 9.3 (Beyer 2004). I estimated β_i in the RSF using logistic regression (Manly et al. 2002) in STATA 10 (StataCorp, College Station, Texas, USA).

I developed eleven *a-priori* models (Table 2.1) that included variables I deemed to be ecologically meaningful based on previous studies of cougar habitat selection or inferences made during the course of my fieldwork (Burnham and Anderson 2002). In particular, I designed models to test the importance of anthropogenic features as determinants of cougar selection. Predictor variables were tested for collinearity at the home range scale using Pearson's correlation coefficient, and variables with $|r| > 0.7$ for any individual cougar were not used in the same model (Hosmer and Lemeshow 2000).

I generated a RSF for each candidate model for each cougar (total number of models = 528) and used the small sample size correction for Akaike's Information Criterion (AIC_c; Burnham and Anderson 2002) to rank models for each cougar. I then summed AIC_c weights (w_i) for each model across cougars to identify the best population-level model and estimated population-level coefficients using the average across individuals.

Where habitats were available but never used by a cougar, STATA estimates a "perfect predictor". Perfect predictors generate exceptionally large coefficients, and including them when calculating population averages results in unreasonably large coefficients and generates substantial variation around the mean. To circumvent this problem where it occurred, I replaced all perfect predictor coefficients with the largest coefficient estimated for cougars without a perfect predictor and used these adjusted scores to estimate population-level coefficients. Coefficients with confidence intervals that did not overlap zero indicate a consistent population-level pattern.

Because covariates within the model are on multiple scales (e.g., some are binary while others continuous), differences in magnitude among raw coefficient values (β_i) do not indicate which variables within a model are most important. To interpret the relative influence of specific habitat types in the RSF model, I rescaled values for each variable in each pixel to have a mean of 0 and a standard deviation of 1 using Equation 2:

$$x_i^* = \frac{x_i - \bar{x}}{sd} \qquad \text{Equation 2}$$

where x_i^* is the standardized form of a given variable in the i^{th} pixel, x_i, is the original value in the i^{th} pixel, $\bar{x}$ is the mean of all x_i, and sd is the standard deviation of all x_i. I re-ran the top model in STATA using rescaled data to estimate standardized coefficients (β_i^*) for each variable for each cougar. As above, I used individual data to estimate the average coefficient value for the population. The standardized coefficients reflect the amount of change in the RSF that accompanies one standard deviation change in the raw covariate score, thus the size of the standardized coefficients is proportional to that covariate's importance in the model.

Temporal patterns in habitat selection

To evaluate temporal changes in selection patterns, I divided GPS data into locations obtained during the day (between sunrise and sunset) and at night (sunset to sunrise). I then re-estimated the top RSF model for each time period for each cougar. In addition, to determine whether cougars exhibited flexible temporal responses to human activity, I divided cougars into groups exposed to similar levels of anthropogenic disturbance. ―Rural" cougars (n =10) had >5% of their home range composed of private land and/or were exposed to an average building density of >2/km^2 throughout their home range. ―Wilderness" cougars (n = 34) met neither of these criteria and were found exclusively in the western portion of the study area. Within each group, I used a paired t-test with the individual cougar as the unit of analysis to determine whether coefficient values for each habitat feature in the model changed significantly between diel periods. I then used standardized variables to explore variation in the relative importance of different habitat features in models for Rural and Wilderness cougars during the day and at night.

To test the hypothesis that cougars avoid human activity and not human development (e.g., Hebblewhite and Merrill 2008), I evaluated shifts in the distance to buildings and roads for GPS location data obtained at night (low human activity) and during the day (high human activity) in two ways. First, for each of the Rural and Wilderness groups, I used paired t-tests to compare the average distance to anthropogenic features. Second, I calculated temporal selection for habitat around roads and buildings at 30m increments using Manly's α and regressed this against road and building availability to determine how selection changed as distance from anthropogenic features increased. Manly's α is a particularly useful index of selection because it is bound by 0 and 1 where, for binary variables, values above 0.5 indicate selection. I used Equation 3 to calculate Manly's α:

$$\alpha_i = \frac{r_i}{n_i}\left(\frac{1}{\sum_{j=1}^{m}(r_j / n_j)}\right) \qquad \text{Equation 3}$$

where, in a set of j resources ($j = 1, 2, 3,\ldots, m$), α_i is the preference index for resource i, r_i is the proportion of resource type i used by a given cougar and n_i is the proportion of resource type i available within the home range (Krebs 1999).

Assessing Functional Response

To determine if cougars exhibited functional responses in habitat selection, I used a logarithmic function to estimate the relationship between the top-model β coefficients for each habitat type for each cougar to the availability of that habitat type within the individual's home range. I calculated home range availability of each habitat type using the zonal statistics++ application in Hawth's Analysis Tools (Beyer 2004).

RESULTS

Population-level habitat selection

I found considerable variation in habitat-selection patterns among individual cougars, with 8 of the 11 candidate models selected as best for at least one cougar. However, model comparisons using AIC weights (w_i) averaged across all cougars in the population and separately for the Rural and Wilderness sub-groups indicated that the Comprehensive Model consistently performed best (Table 2.2). Responses to five model parameters were consistent at the population level (i.e., 95% confidence limits around the population mean did not overlap 0). I found that cougars selected strongly for edge habitat and rugged terrain while avoiding open habitat and high densities of core forest as well as areas of high road and pipeline density (Table 2.3). Areas of high building density were generally avoided, but not consistently so, as were areas of high well-site and seismic density. Cougars tended to select for south-facing slopes and shrub habitat, but these responses also were not consistent (Table 2.3).

Temporal patterns

I identified clear temporal patterns in cougar habitat selection and differences between Rural and Wilderness sub-groups indicate that cougars respond adaptively to human activity patterns (Figure 2.3). Both groups tended to avoid core forest habitat, yet avoidance diminished significantly during the day (Rural: $t_9 = -2.18$, p = 0.03, Wilderness: $t_{33} = 1.90$, p = 0.03). This pattern was most pronounced for Rural cougars, for which avoidance of core forest was the 2nd most important covariate in the model at night, dropping to 10th during the day. Rural cougars exhibited much stronger responses to low-cover habitats than did Wilderness cougars. While Wilderness cougars switched between avoidance of open habitats during the day and selection at night ($t_{33} = 1.70$, p = 0.049) and selected for shrub overall, Rural cougars avoided both habitats throughout the diel cycle, although avoidance for shrubby areas decreased during the night ($t_9 = 1.94$, p = 0.046). Selection for edge was consistent across groups and temporal periods. Edge was important for all cougars, particularly at night, when it was the most important covariate for Rural cougars and ranked 2nd for Wilderness cougars.

Cougar response to anthropogenic features also fluctuated considerably during different diel periods. Cougars stayed further away from both roads and buildings during the day than they did at night (Figure 2.3). In particular, while cougars demonstrated strong avoidance for habitat < 270m from buildings during the day, avoidance was less pronounced at night when cougars avoided areas < 210m from buildings. Wilderness cougars had a more negative response to buildings than did their Rural counterparts. While building density was the most important covariate for Wilderness cougars during both time periods and for Rural cougars during the day, it dropped to the 6th most important covariate for Rural cougars at night ($t_9 = 2.11$, p = 0.03, Figure 2.2). Although areas of high building density were strongly avoided by most Wilderness cougars, the confidence intervals during day and night were wide, indicating that some individuals accommodated anthropogenic disturbance, even in a wilderness setting (Figure 2.2).

Temporal response to other anthropogenic features also varied between Rural and Wilderness cougars. Rural cougars generally avoided areas of higher road density, although the response was stronger during the day ($t_9 = 2.50$, p = 0.02). Wilderness cougars, however, switched from avoiding areas of high road density during the day to selecting them at night ($t_{33} = 4.41$, p < 0.001). Wilderness cougars also avoided some anthropogenic features to which Rural cougars appeared ambivalent: pipelines, seismic lines, and well-sites. Pipeline density, in particular, was consistently avoided by Wilderness cougars (Figure 2.2) and this parameter was much more important for the Wilderness model during both time periods (ranked 2nd in the day and 3rd at night compared to 11th and 9th respectively for Rural cougars).

Functional response

Some of the variation identified in population-level models can be accounted for by functional responses in cougar habitat selection. Responses to five parameters exhibited significant logarithmic relationships to availability (Figure 2.4). Open habitats were strongly avoided when they made up a large portion of the home range, but were selected when they made up <2.5% of the home range ($r^2_{42} = 0.16$, p<0.05). Conversely, cougars avoided higher pipeline

(r^2_{34} = 0.41, p<0.05) and well-site density (r^2_{41} = 0.10, p<0.05) at low availability and became indifferent as density increased. Selection for rugged terrain declined with availability (r^2_{41} = 0.32, p<0.05) while the selection of south-facing slopes (aspect) became greater as the terrain became more rugged and these slopes more available (r^2_{41} = 0.27, p<0.05).

Functional responses indicate that in landscapes dominated by disturbance, cougars appeared less sensitive to anthropogenic features. This suggests that cougars are capable of modifying habitat selection patterns to use disturbed landscapes, at least across the gradient of disturbance I measured (Figure 2.4). For instance, Rural cougars exposed to higher densities of pipelines, seismic, and well sites, avoided these areas much less than did Wilderness cougars (Figures 2.2 and 2.4). A possible exception to malleable habitat responses by cougars is open habitat such as clear-cuts or pasture, which cougars consistently avoided, especially as the landscape became more fragmented by anthropogenic disturbance.

DISCUSSION

Cougars are thought to be moderately resilient to ecosystem disturbance due to certain ecological and life history traits. Specifically, while the species has the ability to thrive in a wide range of habitats it is limited by low fecundity and requirements for ample prey (Weaver et al. 1996, Beier 2009). Cougars are widely believed to avoid anthropogenic landscape features (Van Dyke 1988, Crooks 2002, Orlando 2008), which would indicate increased anthropogenic development might negatively affect cougar populations. My results, however, indicate that cougars exhibit substantial resilience to anthropogenic landscape change and therefore may be less vulnerable to human development than has previously been suggested (e.g., Logan and Sweanor 2001).

I found that cougars in west-central Alberta were capable of shifting diel habitat selection patterns in response to human activity. Presumably in response to decreased human activity after dark, cougars avoided buildings and roads less strongly at night. I also found that cougars avoided large contiguous expanses of forest less during the day than at night, possibly because these areas of core forest act as a refuge from human activity during the day. These patterns were stronger for Rural cougars than for Wilderness cougars, indicating that Rural cougars may have adapted to higher human presence on the landscape.

Although few other studies have explored temporal variation in cougar habitat selection, presumably because location data were obtained during the day (e.g., diurnal VHF radiotelemetry; Laing 1988, Koehler and Hornocker 1991, Dickson and Beier 2002) or without temporal reference (e.g., snowtracking; Logan and Irwin 1985), those that have present results similar to mine. Preliminary work in Texas and California parks showed individual cougars avoiding areas of high human use during the day but selecting for these areas at night (Ruth 1991, Sweanor et al. 2008). In addition, Orlando et al. (2008) found that cougars were willing to use smaller habitat patches in fragmented landscapes at night when humans were less active.

Temporal variation in habitat selection also has been well documented for other large carnivore species, and several authors consider this behaviour an adaptive response that minimizes risk while optimizing use of desirable habitat (Boydson et al 2003, Hebblewhite and Merrill 2008, Martin et al. 2010). For cougars in west-central Alberta the primary benefit derived from accessing anthropogenic landscapes is prey acquisition. Road corridors, cleared land around buildings, agricultural fields, and gardens often provide prime foraging habitat for ungulates, especially white-tailed deer (Rea 2003). Ungulate habitats near people are further enhanced if people feed them, as they occasionally do in west-central Alberta. In addition, pets near rural homes provide an alternate food source for cougars (Torres et al. 1996, Knopff 2010). A possible reason that Rural cougars select habitats closer to buildings and roads at night than during the day is to access prey in edge habitats, which are considered optimal foraging habitat for cougars (Holmes and Laundré 2006), at times of day when humans are less likely to be encountered.

I also found that cougars demonstrated substantial adaptability to anthropogenic disturbance and human activity in the form of functional responses to certain anthropogenic features. Similar to more sensitive animals such as grizzly bears or wolverines (Weaver et al. 1996, Krebs et al. 2007), cougars responded negatively to low levels of anthropogenic disturbance (i.e., when it is rare in a home range). However, as anthropogenic disturbance increased on the landscape, I found that cougars adapted by modifying their habitat-selection patterns and selecting disturbed habitats more frequently. In anthropogenically disturbed landscapes, functional responses may be the result of trade-offs between forage or prey availability and safety (Hebblewhite and Merrill 2008, Herfindal et al. 2009). Thus, ambivalence to or selection for some anthropogenic landscape features by cougars in rural areas might occur because these features are prevalent in the least disturbed, and presumably safer, parts of a heavily modified landscape—i.e., where there are pipelines, seismic lines, and well sites, there is also more forest and fewer buildings and busy roads. In other words, while cougars in lightly disturbed areas could avoid some anthropogenic features in favor of using areas further from disturbance, cougars in more developed areas that did not have the option of disturbance-free habitats modified their selection around anthropogenic features to maximize habitat availability.

High variability in individual selection patterns, as I observed for cougars in west-central Alberta, can result in population-level models with poor predictive power (Nielsen et al. 2002). Undoubtedly, modeling habitat selection at the population-level yields vastly different results than when selection is modeled at the individual level. At the individual level, I was able to demonstrate the flexibility of cougars to anthropogenic development but, when individual coefficients were averaged to generate a population-level coefficient (as per Fieberg et al. 2010), I found that cougars in my study area exhibited habitat selection patterns comparable to cougars studied elsewhere in western North America. In particular, population-level habitat selection indicated that cougars exhibit a negative response to most anthropogenic features (Van Dyke 1988, Crooks 2002, Orlando et al. 2008). Thus, a failure to account for functional responses and temporal variation in selection leads to an overestimation of the negative impacts of development on cougars and an underestimation of the species' resilience. Importantly, looking at habitat selection at the population level and washing out individual detail could have negative ramifications for management and conservation efforts including misidentifying corridors and underestimating possible areas of conflict. Misinterpreting cougar resilience would occur particularly in studies that did not incorporate a gradient of development and focused primarily on wilderness areas, because cougars in these areas are more likely to demonstrate negative responses to anthropogenic features.

My findings demonstrate that cougars in west-central Alberta have the ability to adapt to ecological disturbance through flexibility in habitat selection patterns and thus have some resilience to anthropogenic development. This resilience provides hope for the long-term conservation of the species despite increasing human demands on the landscape. The adaptability of cougars to withstand development is not limitless, however. Development thresholds past which the adaptability of cougars is sufficient certainly exist (Beier 1995), and identifying specific development thresholds beyond which habitat quality deteriorates rapidly will prove especially useful for practical conservation planning (Radford and Bennett 2004).

Thresholds in habitat selection are defined as a sudden shift in selection corresponding to incremental changes in environmental variables (Suding and Hobbs 2009). Detecting disturbance thresholds has proven challenging, however. While I did not identify thresholds for development densities on the landscape, I was able to identify distances to buildings and roads beyond which cougar selection declined precipitously. Building developments where the distance between buildings is <210m will likely restrict cougar use of the area. Similarly, extensive deforestation will negatively affect cougars. I found that not only was cougar avoidance of open habitats nearly universal, but it became more intense as open habitats constituted larger portions of a cougar's home range. Cougars may be able to use open habitats when alternate cover exists (i.e., rugged terrain) but extensive clearing of forest for timber harvest, rangeland or other forms of development will probably impact cougars negatively. However, cougars typically select edge habitats (Logan and Irwin 1985, Laing 1988, Dickson and Beier 2002, Holmes and Laundré 2006), a pattern that my data also support. For this reason, some deforestation might be beneficial to cougars because it creates edges. Additional information is needed to determine the effects of different structural compositions of forest fragmentation on cougars.

In areas where conservation goals include maintaining or increasing cougar populations, identifying threshold levels of anthropogenic landscape change and ensuring that these are not exceeded will be important for the ongoing conservation of what Logan and Sweanor (2001) have called an ―enduring carnivore". However, the willingness of cougars to use anthropogenically disturbed habitats means that they are somewhat resilient to development. For this reason, maintaining cougar populations in many modified landscapes will hinge on managing cougar-human conflict (Treves and Karanth 2003).

Table 2.1: A priori candidate models used to explain cougar habitat selection in west-central Alberta.

Model no. and name	Model structure
1 Edge1	edge
2 Edge2	edge + open + shrub + terrain
3 Edge3	edge + open + shurb + terrain + building density + road density
4 Edge4	edge + open + terrain + aspect + building density + road density + pipe density + well density
5 Cover1	core forest + edge
6 Cover2	core forest + shrub + terrain + aspect + building density + road density
7 Terrain	terrain + aspect
8 Anth1	building density + road density
9 Anth2	open + building density + road density + pipe density + seismic density + well density
10 Anth3	road density + pipe density + seismic density
11 Comprehensive	edge + open + core forest + shrub + terrain + aspect + building density + road density + pipe density + seismic density + well density

Table 2.2: The three top ranked models with corresponding composite AIC_c weights **(w_i)** for all cougars and divided by Rural and Wilderness subgroups in west-central Alberta during 2005-2008. Composite AIC_c weights were calculated by averaging AIC_c weights for the individually-fit models in each group.

Model name	**All cougars (w_i)**	**Rural (w_i)**	**Wilderness (w_i)**
Comprehensive	0.52	0.87	0.43
Cover2	0.16	0.04	0.20
Edge4	0.15	0.03	0.17

Table 2.3: Population-level model coefficients (β) for the Comprehensive model with counts of the number of cougars that had consistent positive or negative responses to each covariate. Also presented are standardized coefficients (β*) for each parameter. Standardized coefficients are displayed as positive or negative to demonstrate direction of selection, however the absolute values of these coefficients indicate the magnitude of their importance within the model.

Covariate	β	95% CI		Significance			β*
		Lower	Upper	+	–	NS	
edge	**0.55**	0.46	0.63	35	0	7	**0.27**
open	**-0.14**	--0.29	-0.01	7	14	21	**-0.06**
core forest	**-0.43**	-0.82	-0.04	10	17	15	**-0.13**
shrub	**0.13**	-0.28	0.54	8	7	26	**0.02**
terrain	**0.01**	0.00	0.02	16	13	13	**0.26**
aspect	**0.13**	0.01	0.26	11	4	27	**0.06**
build density	**-0.17**	-0.32	-0.01	3	13	19	**-0.67**
road density	**-0.13**	-0.25	0.00	9	16	17	**-0.09**
pipe density	**-0.24**	-0.39	-0.09	5	14	15	**-0.20**
seismic density	**-0.03**	-0.08	0.03	7	13	22	**-0.05**
well density	**-0.12**	-0.20	-0.03	1	5	35	**-0.11**

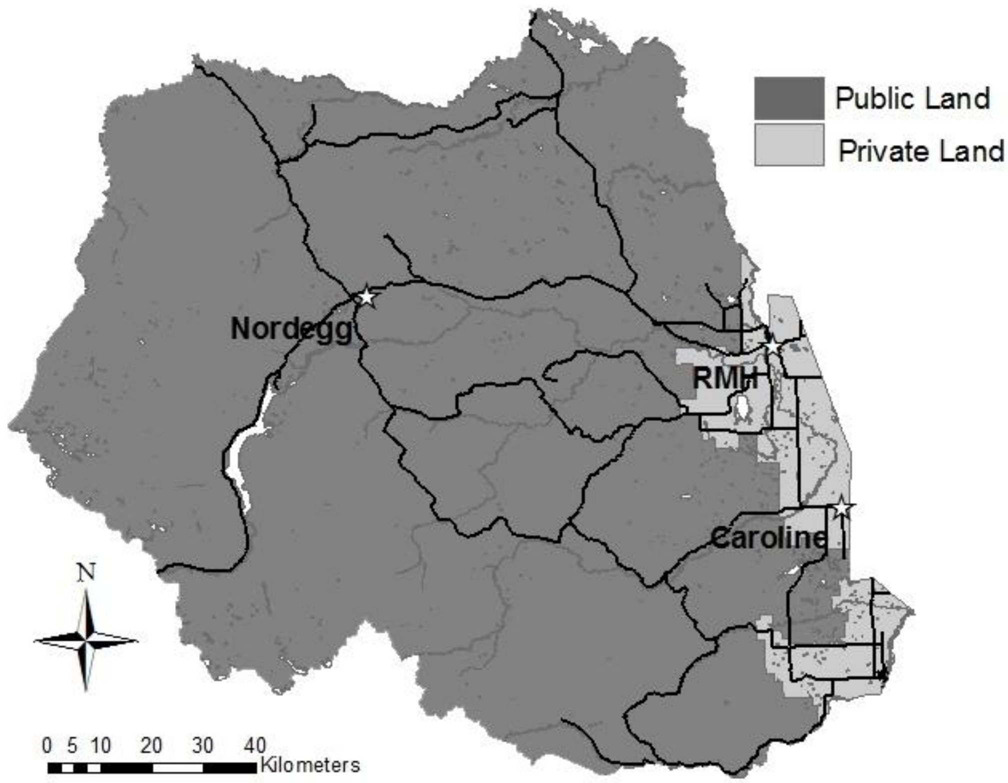

Figure 2.1: Map of the 2005-2008 study area in west-central Alberta depicting land ownership, as well as primary roads (black lines), rivers (grey lines), and lakes (white polygons). Also shown are the three principal towns: Rocky Mountain House (RMH), Caroline, and Nordegg.

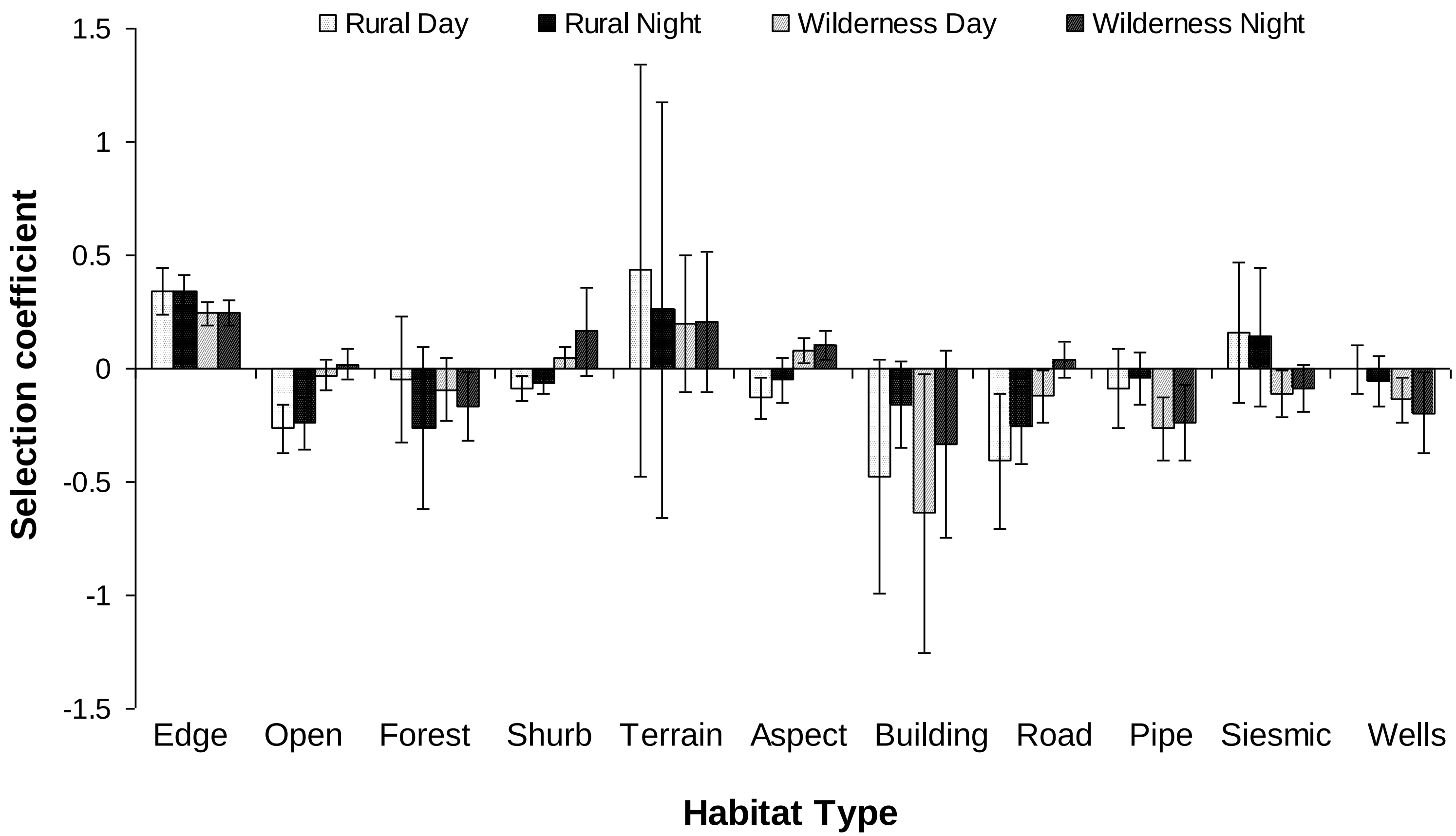

Figure 2.2: Temporally stratified population-level coefficients and 95% CIs for Rural and Wilderness cougar sub-populations in west-central Alberta, Canada during 2005-2008. Individual-level models were run on standardized data to allow for comparison of selection importance between covariates. The magnitude of the bar indicates the importance of the parameter in the model, and the direction (positive or negative), indicates selection or avoidance.

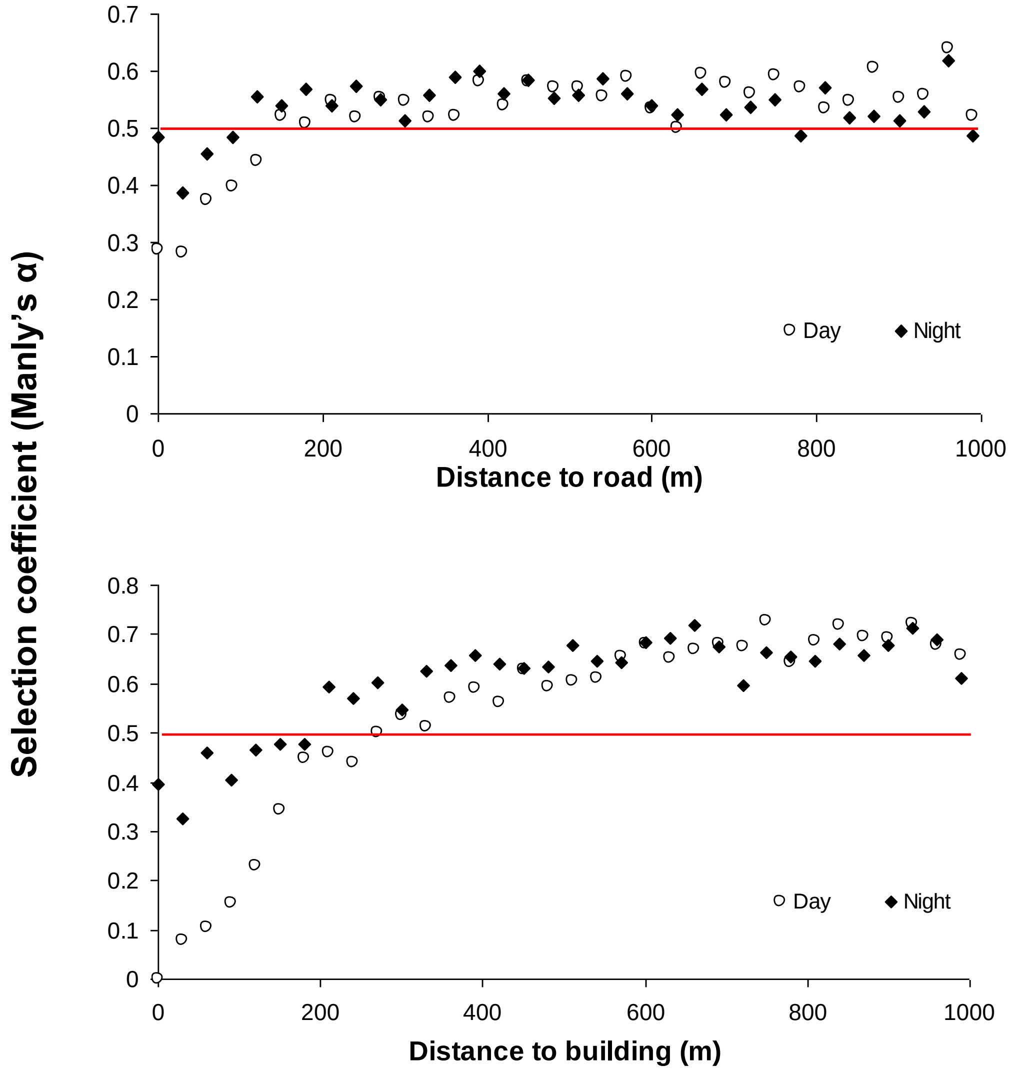

Figure 2.3: Temporal variation in cougar selection at 30m increments from roads and buildings west-central, Alberta. Avoidance occurred for roads at 170m and 210m for buildings. Avoidance was more pronounced during the daytime for both features.

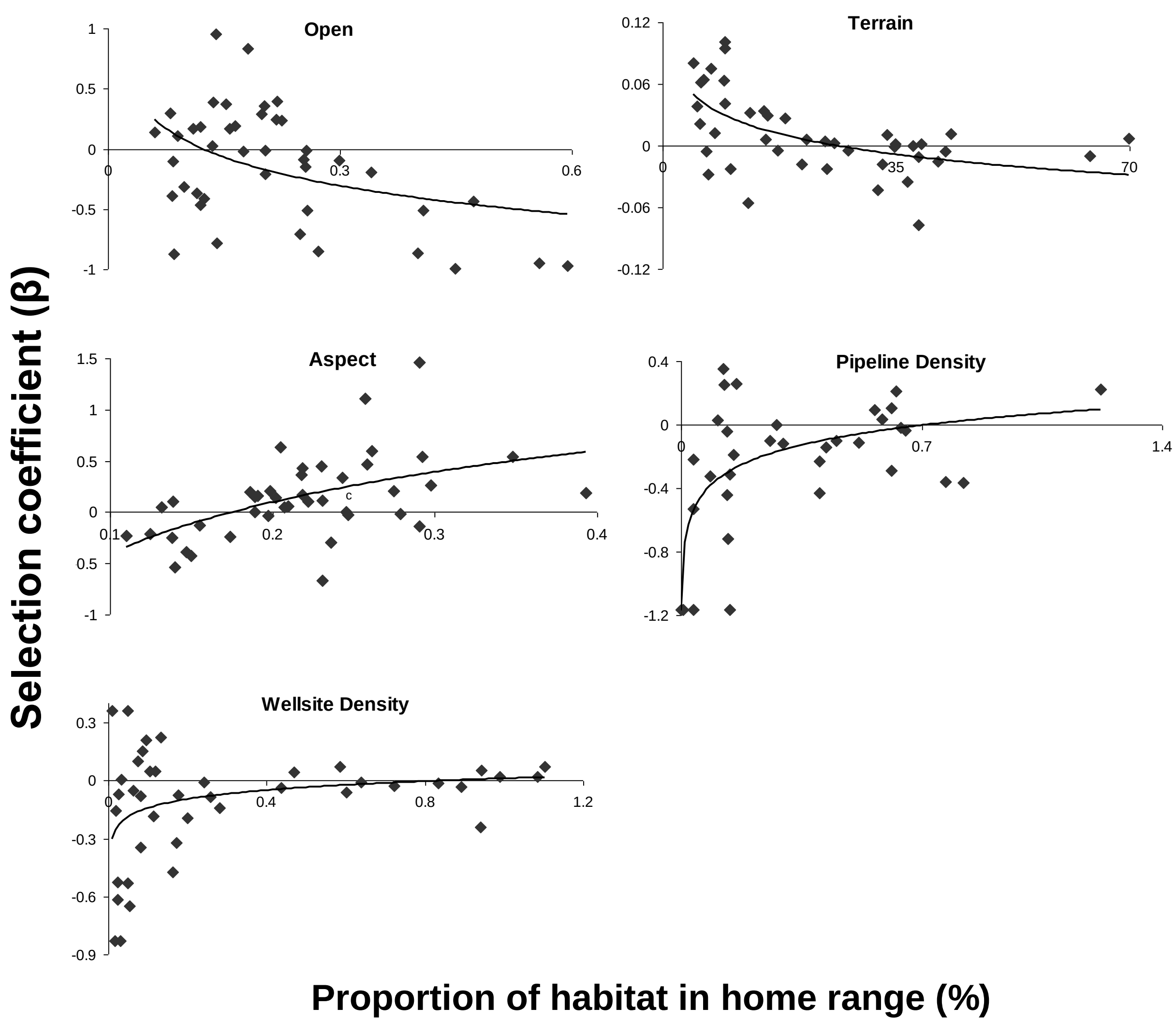

Figure 2.4: Functional responses in resource selection by cougars in west-central Alberta to changing home range availability of five model parameters. Cougar habitat selection did not change in a significant logarithmic fashion in response to differing availabilities of the remaining six variables in the top model: edge, core forest, shrub, building density, road density, and well-site density.

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CHAPTER 3

PREDATORS IN THE BACKYARD: FACTORS AFFECTING TOLERANCE FOR COUGARS IN WEST-CENRTAL ALBERTA

INTRODUCTION

Maintaining populations of large carnivores on increasingly human-dominated landscapes represents a significant conservation challenge (Treves and Karanth 2003). Large carnivores have extensive habitat and prey requirements and much attention has been paid to the problems of habitat loss or degradation for large carnivore conservation (Noss et al. 1996, Weber and Rabinowitz 1996). However, some large carnivores are more resilient to anthropogenic landscape change than is commonly assumed (Chapter 2). In such cases, the danger (real and perceived) large carnivores pose to livestock and people can have important implications for conservation because human societies typically are unwilling to coexist with animals that threaten their lives or livelihoods (Thrigood et al. 2005). Persecution of carnivores as a response to the threats they pose has been a common theme in human history, frequently resulting in depressed populations and occasionally leading to extirpation or extinction (Woodroffe 2000, Woodroffe 2001). Human tolerance, therefore, is a fundamental component of large carnivore conservation in an increasingly anthropogenic world.

The history of cougars (*Puma concolor*) in North America demonstrates the relationship between tolerance and conservation. Because early European settlers saw them as pests, cougars were extirpated from most of eastern North America (except Florida) and their numbers were drastically reduced where they persisted. Pervasive anti-predator sentiment was endorsed by governments, which facilitated cougar removal by bounties and poisoning programs (Kellert et al. 1996, Anderson et al. 2009).

Attitudes and government policies began to change in the 1960s and 1970s, primarily as a result of changing demographics and an increasingly urbanized society with little direct contact with large carnivores (Williams et al. 2002, Manfredo et al. 2003). People began to value large carnivores as big game species (Treves 2009) and icons of wilderness (Gill 2009), and scientists increasingly recognized the potential ecological importance of top predators (Ripple and Beschta 2006). Today, most wildlife management agencies in western North America work to maintain healthy cougar populations (Cougar Management Guidelines Working Group 2005, Anderson et al. 2009). In some states, public ballots have even been used to place restrictions on cougar hunting, or halt it altogether (Mattson and Clark 2009). Changing public opinion and refined cougar management practices resulted in growing cougar populations that have recently begun recolonizing portions of their former range (Anderson et al. 2009, Knopff 2010).

Ironically, cougar recovery has been so successful that more frequent conflict with people may be resulting in shifting public perception in some places. A combination of recovering cougar populations and increasing rural and exurban development means that people regularly share landscapes with cougars, providing greater opportunity for negative cougar-human interactions (Torres et al. 1996, Logan and Sweanor 2001, Baron 2004). Complaints about cougars filed with local fish and wildlife agencies have increased in several jurisdictions (Torres et al. 1996, Cougar Management Guidelines Working Group 2005, Lambert et al. 2006) and comprehensive reviews of cougar attacks on humans during 1890 – 2004 reveal that these are increasing also (Beier 1991, Torres 2005). This new wave of conflict between cougars and humans in North America has been identified as an important complication for the conservation of the species (Hornocker 2009). Lambert et al. (2006) speculate that negative perceptions of cougars are leading to declining populations in parts of Oregon, Washington and British Columbia. In several states, population reduction to lessen conflict with people is again a clear objective of official management plans (e.g., Oregon Department of Fish and Wildlife 2006).

Factors affecting public attitudes towards large carnivores are complex, and tolerance has been associated with value for wildlife (Kellert et al. 1996, Mattson and Clark 2009), socioeconomic status (Naughton-Treves et al. 2003, Mattson and Clark 2009), and social associations (Williams et al. 2002, Naughton-Treves et al. 2003). Risk might be an especially important determinant of tolerance. When people associate high levels of risk with wildlife tolerance and conservation motivation are demonstrably lower (Treves and Karanth 2003). Importantly, risk perception can be just as important in shaping people's views as actual losses to predators (Naughton-Treves and Treves 2005). Because those coexisting with predators face or perceive greater risk (Kellert et al. 1996) proximity to carnivore populations also can influence tolerance (Manfredo et al. 1998, Williams et al. 2002, Karlsson and Sjostrom 2007).

To date, studies that consider the influence of proximity on attitudes do so at a course scale, principally between areas where the species of interest exist and areas where populations are absent or severely limited (e.g. Karlsson and Sjostrom 2007). Proximity to cougars might influence perception not just between societies, but at a finer scale too between individuals. For instance, residents of rural towns may hold more ―urban" views on wildlife and thus have more tolerance for carnivores even though their proximity is relatively close while individuals living on rural farms and acreages might express decreased tolerance because of the increased likelihood they may encounter a carnivore. The influence of fine-scale proximity on tolerance has not been tested.

The objective of this study was to identify the capacity of residents of west-central Alberta to tolerate cougars. Specifically, I investigated the impact on tolerance of six different factors: value for cougars, risk perception, socio-economic factors, social associations, experience with cougars, and proximity. These factors have all been identified previously in the literature as drivers of tolerance for wildlife but their relative importance in influencing tolerance for cougars has not been investigated. In order to include fine-scale proximity to cougar activity as a factor I linked the relative probability that a cougar would use the area around a respondent's home to their returned questionnaire. Using this novel approach, I was able to test the hypothesis proximity to cougar activity is negatively correlated with tolerance. In addition, I also test the hypothesis that risk perception varies positively with proximity to good cougar habitat.

METHODS

Study Area

Alberta is an ideal location to investigate human tolerance for cougars in an increasingly anthropogenic landscape. Provincial cougar populations have increased and expanded their range since the late 1980s (Knopff 2010) and human population growth over this same period has been extensive, especially in areas abutting the eastern edge of the Rocky Mountains where cougars are most numerous (Duke et al. 2003, Alberta Agriculture and Rural Development 2010). I studied public attitudes towards cougars in Clearwater County in west-central Alberta. Most of the human population occurs in the eastern portion of the county (Figure 3.1), and 65% of the county's 11,826 residents lived in either Rocky Mountain House (population 7,231) or Caroline (population 515), with the remainder living in smaller hamlets (e.g., Nordegg, population ~70) or on ranches or small acreages. The cougar population in Clearwater County has increased by at least 250% in the last two decades (Knopff 2010), and cougars continue to occur in the eastern portion of the county, where they have adapted to anthropogenic landscapes by altering their habitat selection patterns (Chapter 2). Ungulate prey – primarily white-tailed and mule deer (*Odocoileus virginianus* and *O. hemionus*) but also elk (*Cervus elaphus*) moose (*Alces alces*) and bighorn sheep (*Ovis canadensis*) – were abundant throughout the study area, and were the primary food source for cougars (Knopff et al. 2010). Livestock and pets also were available as potential prey in the eastern portion of the county, but were infrequently killed by cougars (Knopff et al. 2010).

Survey Instrument and Administration

I used a survey to assess the factors influencing tolerance by Clearwater County residents for cougars. The survey instrument was a drop-off, mail-back questionnaire (Appendix I) designed to identify respondent's tolerance for cougar-human coexistence, experience with cougars, perceived risk and preferred management actions in response to cougar-human conflict. In addition, I requested demographic information (age, sex, education, activities, pet and livestock ownership, organizational affiliations) to determine how these variables affected tolerance. The questionnaire included a background-information section with a photograph of a cougar and eight bullets outlining identification and natural history characteristics of cougars. The design and implementation of the questionnaire was approved by the University of Alberta Arts, Science & Law Research Ethics Board (application number: 1763, CDH08-51).

Two sets of questions were used to quantify tolerance, which was the primary response variable for this study (Table 3.2). The first set of questions asked whether humans and cougars should co-exist in (a) rural residential areas (b) communities in national parks (c) urban areas. The second set asked whether respondents thought it was appropriate to shoot a cougar if (a) you saw a cougar on your property (b) you saw a cougar near your home (c) a cougar threatened you or another person (d) a cougar threatened a pet (e) a cougar threatened livestock. Both sets questions were scaled in 5 options from strongly agree to strongly disagree. Separate averages were calculated for each set of questions and the mean of the two was used to estimate tolerance.

Other questions posed to respondents were designed to quantify various attributes of respondents that might affect tolerance for cougars (Table 3.1). The responses to several questions were used directly to quantify respondent attributes (e.g., respondent age), but in 2 cases attributes were estimated from a suite of questions. One set of questions was used to generate the variable RISK, which describes the perception respondents have of the threat cougars pose. I asked respondents to rank the likelihood of the following scenarios on a five point scale: (a) encountering a cougar near your home (b) being attacked by a cougar near your home (c) your pet being attacked by a cougar near your home (d) your livestock being attacked by a cougar. I averaged responses for these 4 questions to estimate RISK. Possible responses to questions about RISK were scaled using 5 categorical options ranging from very likely to unlikely. Similarly, I used the average score from 3 questions were used to generate the variable VALUE, which describes the degree to which respondents value cougars. The questions were: ―The presence of cougars is a sign of a healthy environment", "It is important to me that cougars persist in Alberta for future generations", and ―It is important to me to know that cougars exist, even if I never see one in the wild". Possible responses to questions about VALUE were scaled using 5 categorical options ranging from strongly agree to strongly disagree.

The survey was administered during May 2008. I contacted randomly selected residents of Clearwater County by telephone to request their participation (n = 479). The following week, I distributed the questionnaire to the homes of willing participants (n = 335) and included a pre-addressed postage-paid envelope so that it could easily be returned. Surveys were numbered, and at the time of drop-off the location of participant's home was recorded using a handheld GPS (Figure 3.1) and assigned to that number. Participants that did not return the questionnaire within one month (n = 138) were contacted again via telephone to remind them of the survey and an additional questionnaire was mailed. A total of 247 questionnaires were returned, yielding a response rate of 52% of all households contacted and 74% of willing participants.

Cougar habitat selection

In order to link the questionnaires to the relative probability of cougar habitat selection around a participant's home, I mapped the resource selection function (RSF) for cougar habitat selection generated in Chapter 2. In order to correct β-values to include observed functional responses (Chapter 2), I followed Hebblewhite and Merrill (2008) and used a moving window based on the radius of a cougar's average home range size to calculate home range composition of open habitat, aspect, terrain ruggedness, pipeline density and well-site density. I used a moving window with a 9-km radius, representative of the average 100% MCP home range size (260km^2) of an adult female cougar monitored with GPS collar for >190 days (for details on duration of monitoring, see Knopff 2010).

The logarithmic functional response between each covariate and within-home range availability was then used to generate spatially explicit β-layers. These layers were then substituted as the coefficient for the covariate in the RSF equation. Predicted relative probabilities of cougar landscape use were rescaled between 0 and 1 (Manly et al. 2002). I then generated an average RSF score for window with a 500-m radius around the location of each home and intersected this score with the appropriate questionnaire.

Data Analyses

I used a multiple working hypothesis framework (Burnham and Anderson 2002) to evaluate drivers of tolerance for cougars by residents of Clearwater County. I generated 7 *a-priori* models and used Akaike's Information Criterion (AIC_c) to evaluate the weight of evidence for each model. Log-likelihoods for each model were calculated using the generalized linear model with a Gaussian link in STATA 10 (StataCorp, College Station, Texas, USA).

Each candidate model included a combination of 6 groups of variables thought to influence tolerance. Each group included different numbers of predictor variables (Table 3.1), and groups were included or excluded from candidate models as cohesive units (Table 3.2). Predictor variable groups were: (1) socio-economic variables commonly used in studies of human attitudes towards wildlife (2) variables describing experience with cougars (3) the value respondents associated with cougars (4) variables describing the outdoor activities in which respondents were active (5) risk respondents associated with cougars and

(6) RSF scores describing the relative probability of cougar selection of habitat within 500m of the respondent's home. To avoid multicollinearity, variables correlated at |r| > 0.7 were not used in the same model.

To interpret the relative importance of each variable retained in the top model, I calculated coefficients using standardized variable scores using Equation 1:

$$x_i^* = \frac{x_i - \bar{x}}{sd} \qquad \text{Equation 1}$$

where x_i^* is the standardized form of a given question score for the i^{th} questionnaire, x_i, is the original value in the i^{th} questionnaire, $\bar{x}$ is the mean of all x_i, and sd is the standard deviation of all x_i. The standardized coefficients reflect the amount of change in tolerance that accompanies one standard deviation change in the raw covariate score. Thus, the absolute value of the standardized coefficients is proportional to that covariate's importance in the model.

Finally, to test if risk perception was linked to proximity to cougar activity, I regressed risk perception against proximity and used Pearson's r to test for collinearity.

RESULTS

Respondent characteristics

Survey respondents were mostly long term residents of Clearwater County (mean = 29 years, SD = 20 years). Respondents tended to be male (58%), with an average age of 54 years (range 20 – 89, SD = 13 years). Approximately one third

(27%) had children living at home. Most respondents (75%) had completed high school, with a large portion having attended at least one year of college or university (41%). Fifteen percent attended university for ≥ 4 years. Ranchers constituted 28% of respondents; an additional 22% owned livestock but did not consider themselves ranchers. Ninety percent owned some type of animal (livestock, dog, or cat). The vast majority of respondents (90%) participated in outdoor activities and a large portion (35%) were hunters. While active outdoors, few respondents were members of a hunting (9%), conservation (5%), or outdoor activity (9%) organization.

A majority of respondents (54%) reported having a personal experience with a cougar. Positive experiences with cougars were not uncommon (51% strictly positive, 34% both positive and negative). Only 15% of respondent's experiences with cougars were strictly negative. Of those that had not had a personal experience with a cougar, the most common sources of information about cougars were media reports (84%) and stories told by acquaintances (82%), whereas presentations (45%) or books about cougars (30%) were accessed less frequently.

Few respondents considered their overall feelings towards cougars negative (15%). Respondents generally felt that the presence of cougars was important for a healthy ecosystem (65% agree), and that the continued presence of cougars in Alberta was important (76% agree). Most, however, did not feel that the presence of cougars near their homes increased their overall quality of life

(57% disagree) and only a small minority thought that the cougar population within 1-km from their home should increase (3%).

Although most respondents did not believe that cougars commonly used areas within 1-km of their home (75%), there was still a strong perception that an interaction with a cougar was likely. A majority of respondents (64%) believed that it was at least likely that they would encounter a cougar near their home, or that their livestock would be attacked (60%). Half believed that there was a likelihood that their pets would be attacked (50%) and 25% thought that they were personally at risk of a cougar attack (Figure 3.2). Interestingly, 31% of respondents believed that they faced higher risk of being attacked by a cougar than being injured in a car accident, and 24% felt the risk was about the same.

Respondents generally agreed that cougars and humans should coexist in National and Provincial Parks (77% agreement for coexistence), but were split about whether coexistence should occur in rural areas (36% agree, 40% disagree, 24% neutral), and strongly opposed to coexistence in urban areas (84% disagree). Tolerance for interactions with cougars decreased depending on the severity of interaction. While a minority of respondents (18%) supporting shooting a cougar if it was sighted away from their home on their property, this number increased sharply if pets, livestock or people were threatened. Most respondents thought that cougars should be shot if they placed pets, livestock or people in danger (Figure 3.3).

Factors affecting tolerance

Tolerance was best explained by the model that incorporated all six variable classes (Table 3.3). The four covariates with the strongest influence on tolerance were value, hunting, age, and risk perception. Value for cougars was by far the strongest predictor of tolerance (Table 3.4) and had double the impact of the next strongest covariate, hunting. The perception that coexisting with cougars posed a high risk was twice as important in influencing tolerance levels as personal experience with cougars or living in proximity to areas of high cougar activity.

Cougar selection near homes

Respondents were split between urban (19%) and rural (81%) areas within Clearwater County. The relative probability of cougar use within 500m of respondents' homes varied over 1000-fold ($x_{234} = 0.82$, SE = 0.27). The respondent's home with the lowest relative probability of cougar habitat selection within a 500-m radius was located in Rocky Mountain House, and the home surrounded by land with the highest relative probability of cougar selection was located approximately 15-km north of Rocky Mountain House along the banks of the North Saskatchewan River. The relative probability of cougar selection near homes was retained in the top model, and the effect of the variable on tolerance was weakly positive (Table 3.4). Contrary to expectation, moreover, risk perception correlated poorly with probability of cougar selection (Figure 3.4, $r^2_{235} = 0.06$, $p < 0.05$).

DISCUSSION

Anti-predator sentiment can be deeply ingrained in human culture, sometimes lasting centuries after predators have been extirpated, hampering conservation efforts (Kellert et al. 1996). For many North Americans, however, cougars are no longer seen as a threat to be controlled or a resource to be exploited; rather, they are valued for their ecological role and aesthetic beauty (Mattson and Clark 2009). I found that in rural Alberta, value for cougars tended to be high and that majority of individuals wanted to see cougars persist in Alberta and believed that they played an important ecological role. These results are encouraging from a conservation perspective.

However, survey respondents were less willing to support cougar-human coexistence as the landscape became more urban, and were overall more willing to shoot a cougar as the severity of a hypothetical conflict scenario increased. A prevailing sentiment was that cougars belonged in the ―wilderness" and not close to home. In other words, Clearwater County residents were supportive of cougar conservation so long as that did not mean more cougars near their homes. Such ―not in my backyard" sentiment appears to be common with respect to large carnivores (Riley and Decker 2002, Ericksson et al. 2008). Unfortunately, increasing rural and exurban development means that the size of the ―backyard" in North American landscapes is growing. The conservation challenge, therefore, is to determine what might encourage people to accept cougars on increasingly developed landscapes.

The amount of risk that people associate with cougars, for instance, has an important impact on tolerance. Perceived risk has been closely linked to tolerance throughout the human-wildlife conflict literature (Decker et al. 2002, Røskaft et al. 2003) and a negative correlation between risk and tolerance has been documented repeatedly for carnivores in North America (Riley and Decker 2002, Naughton-Treves et al. 2003). Risk perception drove post-settlement persecution of carnivores by European Americans (Coleman 2004), and I found that risk perception was the fourth most important driver of tolerance for cougars in Alberta's Clearwater County. Consequently, it is important to address this issue in the midst increasing human-cougar overlap on landscapes in Alberta and elsewhere in North America.

The amount of risk respondents associated with cougars in west-central Alberta was higher than the actual risk. Only one person has been killed by a cougar in Alberta in the past 100 years (Torres 2005). By comparison, >120,000 motor vehicle accidents were reported annually in Alberta over a five year period from 2004 through 2008 resulting in an average of 382 fatalities per year (Alberta Transportation 2008). Yet, 55% of respondents felt that coexisting with cougars posed at least the same amount of risk as driving. Overestimation of the risk posed by cougars is not without precedent. Riley (1998) found that ~20% of Montanans felt that cougars posed a greater risk to the risk of riding in an automobile. Livestock and pet depredations by cougars, while much more common than attacks on people, are also rare in the Clearwater County (Knopff

2010). Nevertheless, these events were also seen as a likely outcome of coexisting with cougars.

It is possible that the disjointed risk perception associated with cougars is the result of a cognitive illusion. Cognitive illusions occur when rare events are so easily recalled that individuals over-estimate their frequency (Kahneman and Tversky 1996). With regard to human-wildlife conflict, situations with severe consequences – such as a fatal attack by a cougar – have the effect of elevating perceived risks even if the likelihood of the event is low (Decker et al. 2002). The media can play an important role in amplifying fear of carnivores (Gore and Knuth 2009) and the prevalence of reports following a negative encounter likely strengthen the illusion that these types of encounters are common. Humans have a long evolutionary history with large carnivores that produces a natural, and rational, fear (Kruuk 2002). To enhance conservation prospects for large carnivores, however, it is important to keep these risks in perspective.

In addition to risks posed by cougars to people and livestock, the risks (real and perceived) they pose to ungulate populations also influence tolerance. I found that whether or not a respondent was a hunter was the second most important factor influencing tolerance for cougars: hunters were substantially less tolerant than non-hunters. A number of hunters expressed concern about the potential influence of cougars on game populations, suggesting that too many cougars were present on the landscape reducing deer and elk numbers. Hunters are motivated to conserve ungulate populations, and because carnivores threaten these populations and are a source of competition, tolerance is reduced (Holsman 2000, Treves 2009).

Risk perception and tolerance have been linked to proximity to carnivore populations in surveys of attitudes on both cougars and wolves (Riley and Decker 2002, Karlsson and Sjostrom 2007). Riley and Decker (2002), for instance, found that while a minority of Montanans felt that they were at personal risk of conflict with a cougar, risk perception increased from the eastern part of the state (where few cougars persist) to the west (where cougars are common). Similarly, Karlsson and Sjostrom (2007) found that attitudes towards wolves in Sweden improved at distances greater than 150-200km from the nearest wolf territory. This relationship has not been tested at finer scales, however. I used a RSF derived from GPS location data to estimate the relative probability that a cougar would select habitat within 500m of a respondent's home and linked this information to their returned questionnaire. By applying this novel approach, I was able to test the hypothesis that individuals within a community who live where the relative probability of cougar selection is higher would be less tolerant of cougars.

Although the relationship between probability of cougar selection and risk perception remained positive, it was weak and insignificant. Moreover, I found that tolerance was positively related to the probability of cougar selection near a home, directly contradicting my predictions. Thus, all else being equal, residents within towns (the lowest probability of cougar selection in the Clearwater County) may be just as fearful and less tolerant of cougars than those exposed to greater risk (higher probability of selection) near their homes. The negative correlation between proximity and tolerance may not hold at the community scale because the community overall is so close to cougar activity that people are not disassociated from the challenges of coexisting with carnivores in the same way they are when they live in major urban centers.

Tolerance is often associated with age, socio-economic status, and occupation (Kellert 1996, Williams et al. 2002). I found that older members of the community, hunters, and ranchers had less tolerance for coexisting with cougars. Similar to what Williams et al. (2002) and Naughton-Treves et al. (2003) found for wolf tolerance in the United States, Mattson and Clark (2009) showed that these groups tended to hold more traditional views about cougars, often seeing them primarily as a competitor for game, threat to livestock, or economic resource. Tolerance tends to be positively correlated with education (Williams et al. 2002, Manfredo et al. 2003, Naughton-Treves et al. 2003). This finding is typical for studies of attitudes towards predators and may reflect a value shift as a result of a broader worldview (Naughton-Treves et al. 2003). In west-central Alberta, tolerance for cougars increased with higher levels of education, further supporting this concept.

Because of its positive association with tolerance, providing educational opportunities may be an effective way to increase the willingness of local populations to coexist with cougars. This is especially true if education can increase the overall value an individual has for cougars, or address inappropriate perceptions of risk. Yet it is unclear how effective traditional wildlife education programs are, and some of them might even reinforce negative attitudes (Kellert et al. 1996). Perhaps more important for the long term conservation of carnivores is an opportunity to be directly exposed to these animals and the chance to learn about their ecological importance (van den Born et al. 2001, Louv 2008). Experiential educational programs such as Project C.A.T. (cougars and teaching) in Washington State provide opportunities for students to have hands-on experience with cougars (Griswold et al. 2008) and may be more effective at creating positive wildlife values (van den Born et al. 2001). Expansion of this type of program throughout cougar range might be an important way to promote long-term support for coexistence within rural communities.

Table 3.1: Definitions of variables used in questionnaire analysis.

Variable	**Type**	**Definition**	**Category**
Tolerance	Continuous between 1 - 5	1 = low tolerance for coexisting with cougars, 5 = high tolerance	TOLERANCE (Response variable)
Value	Continuous between 1 - 4	1 = low value for cougars, 4 = high value for cougars	VALUE
Risk	Continuous between 1 - 4	1 = low risk perception, 4 = high risk perception	RISK
Schooling	Categorical	Level of education: 1 = high school, 2 = some college or university, 3 = undergraduate degree, or 4 = graduate degree	Socio-econ
Ranching	Binary	Is the respondent a rancher? (1 = yes, 0 = no)	Socio-econ
Livestock	Binary	Does the respondent own livestock? (1 = yes, 0 = no)	Socio-econ
Age	Continuous	Years of age	Socio-econ
Children	Binary	Are children present (1 = yes, 0 = no)	Socio-econ

Gender	Binary	Male or female (1 = female, 0 = male)	Socio-econ
Pets	Binary	Does the respondent own a pet? (1 = yes, 0 = no)	Socio-econ
Story	Binary	Has the respondent been exposed to a story about cougars from a friend? (1 = yes, 0 = no)	Experience
Presentation	Binary	Has the respondent been exposed to a presentation about cougars? (1 = yes, 0 = no)	Experience
Personal interaction	Binary	Has the respondent had a personal interaction with a cougar? (1 = yes, 0 = no)	Experience
Media exposure	Binary	Has the respondent been exposed to cougars through the media? (1 = yes, 0 = no)	Experience
Hunting	Binary	Is the respondent a hunter? (1 = yes, 0 = no)	Activities
Outdoor recreation	Binary	Does the respondent participate in outdoor activities (1 = yes, 0 = no)	Activities

Proximity	Continuous	RSF score at a 500m radius around the home, 0 for lowest relative probability of cougar use, 1 for highest	Proximity

Table 3.2: *A-priori* candidate models used to explain tolerance for cougars in Clearwater County Alberta.

Model no.	Model structure
1	RISK + Proximity
2	Proximity + Experience + Activity
3	Socio-econ + RISK
4	VALUE + Activity + Experience
5	RISK + Proximity + Experience
6	VALUE + Socio-econ
7	VALUE + RISK + Proximity + Socio-econ + Experience + Activity

Table 3.3: Ordered generalized logistic models used to describe tolerance for coexisting with cougars in Clearwater County, Alberta. Model log-likelihood (LL), number of estimated parameters (K), Akaike's Information Criterion (AIC), AIC difference (ΔAIC), and AIC weight (w_i) are displayed.

Rank	**Variables**	**LL**	**K**	**AIC**	**ΔAIC**	w_i
1	Value + risk + proximity + socio-econ + experience + activity	-196.08	16	424.16	0.00	1.00
2	Risk + Proximity + experience + socio-econ	-219.70	13	465.40	41.24	0.00
3	Value + activity + experience	-227.75	7	469.50	45.34	0.00
4	Value + socio-econ	-234.45	8	484.90	60.74	0.00
5	Proximity + experience	-245.06	5	500.12	76.00	0.00
6	Socio-econ + risk	-252.90	8	521.80	97.63	0.00
7	Risk + proximity	-262.46	2	528.91	104.76	0.00

Table 3.4: Descriptive statistics and ordered generalized linear regression results for the top model predicting tolerance for cougars in Clearwater County, Alberta.

Variable	Std. coef.	Coef.	Mean	Std. Dev.	Min.	Max.
Value	0.33	0.35	4.16	0.93	1	5
Hunting	-0.15	-0.31	0.35	0.48	0	1
Age	-0.14	-0.01	54.34	13.38	20	89
Risk	-0.11	-0.09	2.51	1.21	1	5
Schooling	0.10	0.10	2.37	1.00	1	4
Ranching	-0.09	-0.20	0.28	0.45	0	1
Children	-0.09	-0.20	0.27	0.45	0	1
Pets	0.07	0.17	0.81	0.39	0	1
Personal	0.06	0.11	0.53	0.50	0	1
Story	-0.05	-0.17	0.89	0.31	0	1
Proximity	0.05	0.18	0.82	0.28	0	0.99
Livestock	0.04	0.07	0.49	0.50	0	1
Presentation	0.03	0.05	0.52	0.50	0	1

Media	-0.02	-0.06	0.89	0.31	0	1
Gender	-0.02	-0.04	0.42	0.49	0	1
Outdoor rec.	0.00	0.00	0.91	0.29	0	1

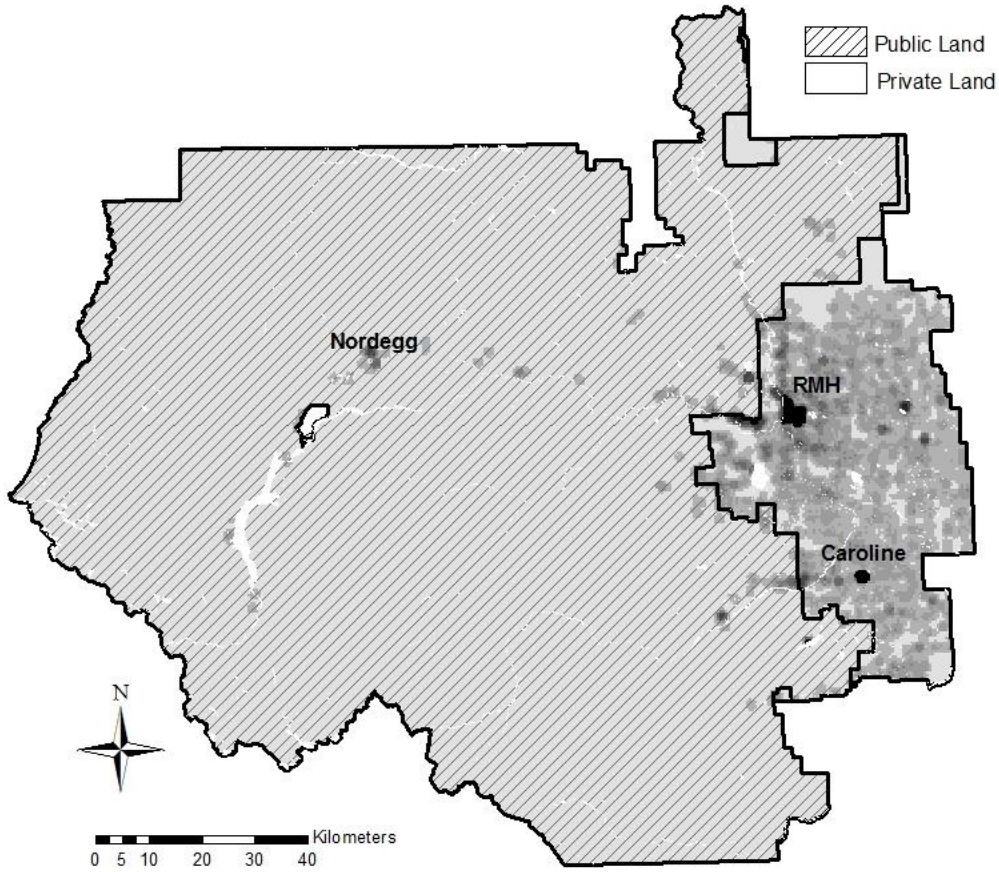

Figure 3.1: Map of Clearwater County depicting the gradient of human population density. The lightest grey areas have a density of <1 buildling/km^2 while the darkest are >200 bulidings/km^2. Also shown is the divide between public and private land, lakes and rivers (white), and the three principal towns: Rocky Mountain House (RMH), Caroline, and Nordegg.

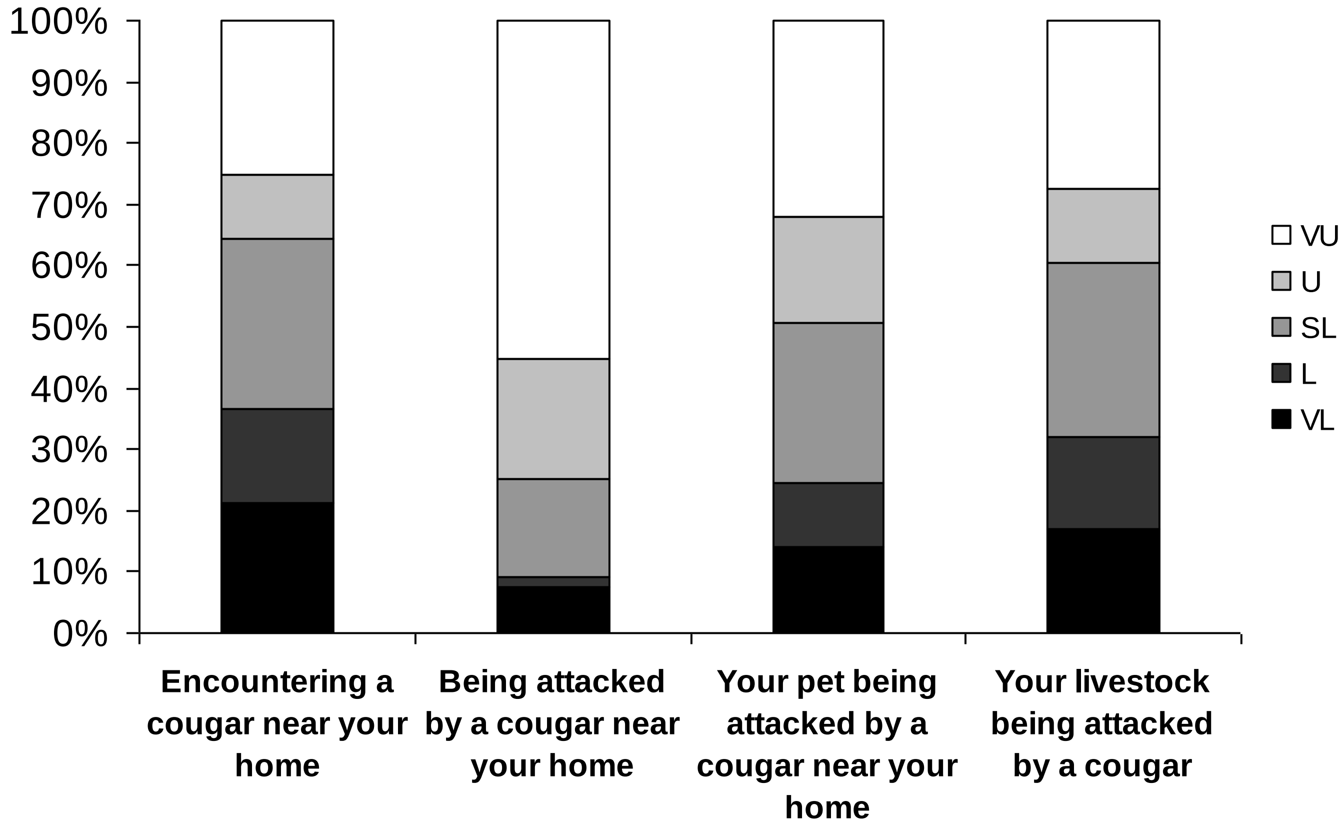

Figure 3.2: The likelihood that respondents to the Clearwater County Cougar Survey believed that they would have an interaction with a cougar near their home. VL = very likely, L = likely, SL = somewhat likely, U = unsure, VU = very unlikely.

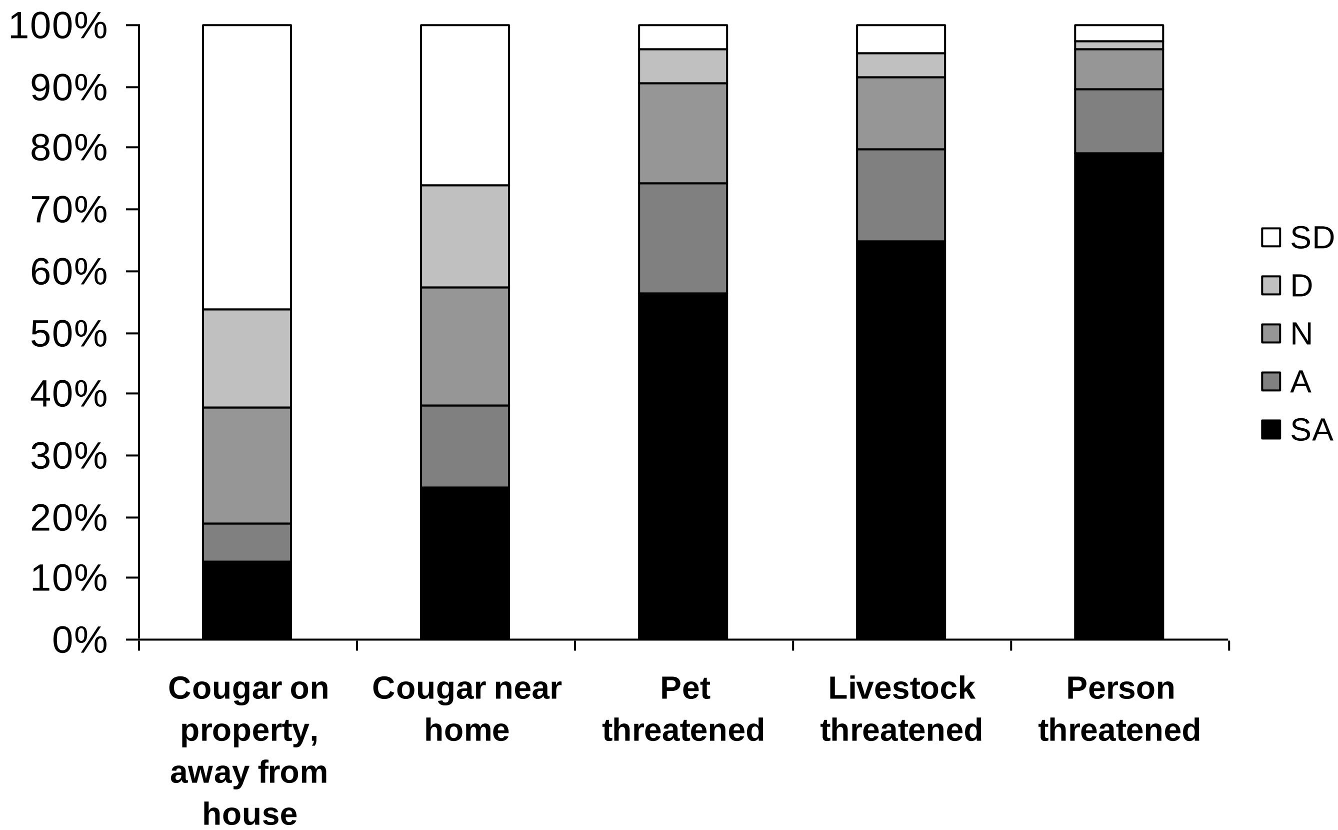

Figure 3.3: The tolerance of survey respondents to cougar-human interaction scenarios. Respondents were asked if how much they agreed that shooting a cougar would be the appropriate course of action for each scenario. Most respondents would tolerate seeing a cougar on their property, but not having livestock, pets or people threatened. SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree.

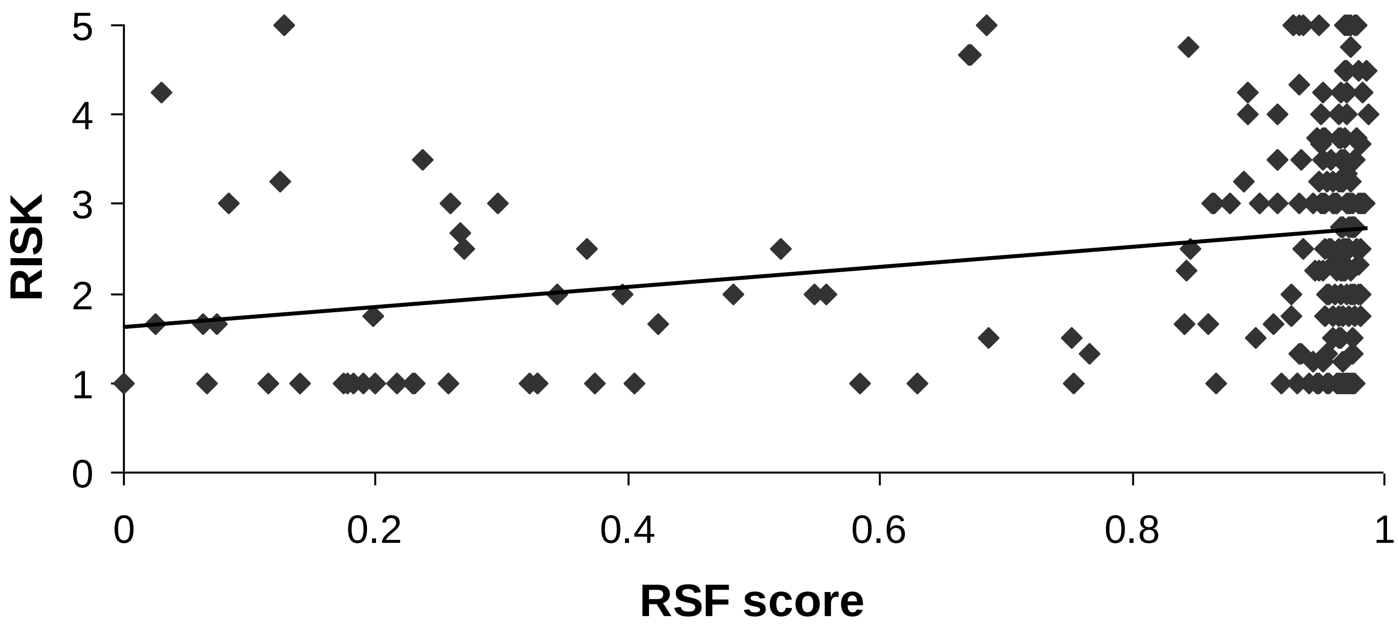

Figure 3.4: Relationship between the amount of risk survey respondents from Clearwater County, Alberta associated with coexisting with cougars and the probability of cougar selection for habitat within a 500m radius around the respondent's home (RSF score).

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CHAPTER 4
THESIS SUMMARY

Large carnivores and humans have a tumultuous history (Quammen 2003). Simultaneously revered for their power and beauty and persecuted for the threats they pose to humans and animals, large carnivore population stability has often hinged on conflict with humans (Treves and Karanth 2003, Gill 2009). The potential for conflict between humans and large carnivores in western North America is increasing as anthropogenic presence on the landscape escalates (Noss et al. 1996, Logan and Sweanor 2001). Simultaneously, these same landscapes are being rapidly altered, potentially reducing habitat suitability for large carnivores (Weaver et al. 1996). If large carnivores and humans cannot coexist on the same landscapes carnivores may be permanently relegated to dwindling reserves of remote wilderness (Woodroffe et al. 2005). Thus, conservation prospects for large carnivores depends on their resilience to habitat modification and the tolerance of local human populations. The goal of this thesis was to examine these components of cougar (*Puma concolor*) conservation and explore prospects for cougars in a rapidly developing rural landscape in west-central Alberta.

In Chapter 2, I showed that cougars can adapt to some anthropogenic landscape modification and can persist in rural and exurban environments. The negative response that cougars displayed to anthropogenic features decreased both as the prevalence of these features increased on the landscape (functional response in habitat selection) and at night, when human activity waned. Responses were more pronounced in cougars inhabiting rural landscapes, indicating resilience through behavioral adaptation. Although I did not estimate cougar density across the study area, my perception from several years of tracking cougars in the Clearwater County is that one of the areas that cougar densities might be highest is in rural landscapes. Thus, not only can cougars persist in such landscapes, but they might also thrive.

In fact, the biological resilience of large carnivores might generally be higher than commonly thought. The belief that anthropogenic habitats are unsuitable for large carnivores might overestimate the sensitivity of carnivores to habitat change and underestimate the importance of proper management in maintaining these species on the landscape (Linnell et al. 2001). Several species of large carnivores are currently repopulating portions of Europe and North America (Breitenmoser 1998, Linnell et al. 2001, Anderson et al. 2009), despite increasing landscape development. Thus, given the opportunity, species such as wolves (*Canis lupus*), cougars, and grizzly bears (*Ursus arctos*) might do well in modified landscapes (Boitani et al. 2010). For cougars in rural Alberta, this opportunity hinges on the willingness of the public to coexist with cougars.

In Chapter 3, I showed that residents of west-central Alberta valued maintaining cougars on the landscape yet tolerance was limited by perceptions about the amount of risk cougars posed to humans, livestock and ungulate populations. When respondents were asked for comments about cougars, remarks about being ―terrified", afraid to leave the home, to let children out, were not uncommon. Living with carnivores means that caution must be exerted (Torres

2005), but if it negatively impacts quality of life, motivation for conservation and coexistence can be diminished (Thirgood et al. 2005, Treves et al. 2006).

Appropriate management action to deal with conflict is critical (Treves and Karanth 2003). Alberta Sustainable Resource Development (ASRD) already has a conflict response protocol in place that recommends translocation or euthanisation of problem cougars. Another aspect of conflict that is just as important, but perhaps harder to deal with, is addressing local reservations about cougars and cougar management (Linnell et al. 2005). Rumors about ASRD practices abound, and although humorous in many regards, the common myth that the department is helping to reestablish cougar populations by releasing animals from helicopters or horse trailers has serious ramifications. Mistrust of the intentions of wildlife management organizations can fuel anti-predator sentiment (Naughton-Treves and Treves 2005). This sentiment, even if held by a minority, can have negatively impact populations (Kellert et al. 1996). Coupled with overblown risk perceptions, the conservation prospects for cougars outside of the public lands in Alberta diminish.

Support for coexisting with cougars may be enhanced through education programs that promote value for cougars, address many of the misconceptions, and provide local populations with the tools necessary to coexist safely with these large carnivores. In addition, management action may be implemented to reflect the expectation of responsible coexistence. Although already a wildlife infraction, is not uncommon for residents of Clearwater County to feed ungulates in their yards. Ensuring that these types of infractions are addressed, particularly when agency personnel are called out to deal with a problem cougar, presents an opportunity to increase public awareness about wildlife management policies as well as cougar behavior and living safely in cougar country.

In Alberta managing conflict between cougars may currently be the most critical component of cougar conservation. There are, however, almost certainly development thresholds beyond which cougars are incapable of persisting. For example, cougar populations are threatened by habitat loss and fragmentation in California where high density development is occurring at a rapid pace (Beier 1993, Beier and Barrett 1993, Logan and Sweanor 2001). Alberta still has an opportunity to develop its landscapes to facilitate cougar conservation. While cougar conservation is compatible with some development, development thresholds that surpass the resilience of cougars are difficult to determine. Careful planning, therefore, that maintains areas of cover and minimizes high densities of anthropogenic features will aid in achieving the provincial management goal of ensuring that the cougar population is protected from significant decline (Jalkotzy et al. 1992).

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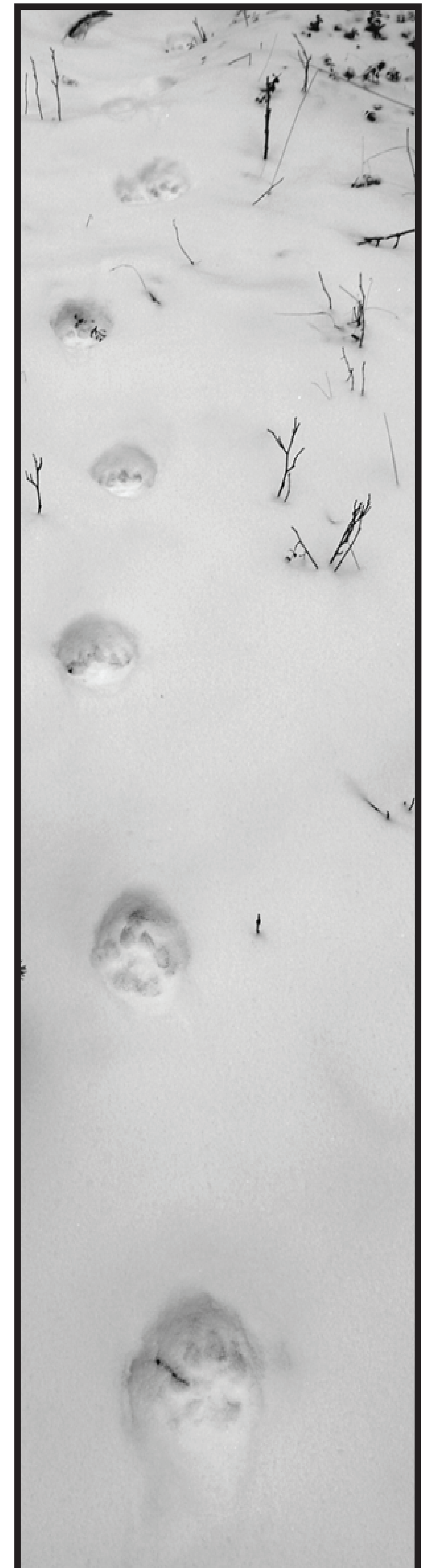
APPENDIX I

SURVEY INSTRUMENT



Clearwater County Cougar Survey

May 2008

UNIVERSITY OF ALBERTA

Alberta
SUSTAINABLE RESOURCE DEVELOPEMENT

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Background Information

Cougar (*Puma Concolor*)

Characteristics of Cougars:

- The largest wild cat in Alberta.
- Usually tawny in color with a cream belly.
- Have long tails and both tails and ears are tipped in black.
- Adult females usually weigh between 80-110lbs and adult males (called toms) weigh between 130-200lbs.
- Cougars are solitary animals and only travel together during mating associations or when females have kittens at heel
- Kittens stay with their mothers until they are up to 20 months old.
- Cougars are also commonly called mountain lion, puma, and panther.
- Cougar populations in Alberta are managed as a hunted animal by Alberta Sustainable Resource Department.

About this Survey

Responses to the questions in this survey will provide University of Alberta researchers and wildlife managers with a better understanding of the views of individuals who coexist with cougars. Data gathered from this survey will be analyzed and results will be used in academic publications, presentations, and considered during the creation of cougar management plans. The University of Alberta will store completed surveys in Edmonton for up to two years.

We appreciate your voluntary participation in this survey. We would like your feedback on as many questions as possible; however, you may choose to complete only part of the survey or leave a question blank. Please return the survey in the included envelope. Responses to this survey will be kept anonymous and names will never be associated with survey responses.

If you have comments or questions please contact Aliah Adams Knopff (403-721-2065) or Dr. Colleen Cassidy St. Clair, Department of Biological Sciences, University of Alberta (780-492-9685).

Section 6: Personal Experiences with Cougars

24. Please use the space below to write any stories about cougars, opinions on human co-existence with cougars, or ideas about management that you would like to share with us.

Thank you for completing this survey. Below are two questions about how we can better pass information about cougar and the results of this survey on to you.

If you wanted to learn more about cougars, how would you prefer to get that information? Please check ***ALL*** that apply.

____ Contact Alberta Sustainable Resource Development Office
____ Talk to a Fish and Wildlife Officer or a Park Warden
____ Ask friends or family
____ Contact an organization that is involved in wildlife or outdoor issues
____ Do research on the Internet or at the library
____ Purchase information at a bookstore
____ Other (please explain)______________________________

If you would like to receive a final report on this project, please provide us with your email address.
E-mail________________________

Section 5: Personality Information. Please rememeber that your responses to this survey are confidential and will be used for analysis purposes only.

23. We are interested in understanding if an individual's personality influences their view on cougars. Below are a number of personality traits that may or may not apply to you. Please circle a single number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

	Disagree Strongly	Disagree Moderately	Disagree a little	Neither Agree or Disagree	Agree a little	Agree moderately	Agree Strongly
	1	**2**	**3**	**4**	**5**	**6**	**7**
Extraverted, enthusiastic	1	2	3	4	5	6	7
Critical, quarrelsome	1	2	3	4	5	6	7
Dependable, self disciplined.	1	2	3	4	5	6	7
Anxious, easily upset	1	2	3	4	5	6	7
Open to new experiences, complex	1	2	3	4	5	6	7
Reserved, quiet	1	2	3	4	5	6	7
Sympathetic, warm	1	2	3	4	5	6	7
Disorganized, careless	1	2	3	4	5	6	7
Calm, emotionally stable	1	2	3	4	5	6	7
Conventional, uncreative	1	2	3	4	5	6	7

Section 1: Background Information. Please rememeber that your responses to this survey are confidential and will be used for analysis purposes only.

1. What types of animals do you own? Please check **all** that apply.

___ Dog ___ Cat ___ Llama ___ Cattle

___ Horse ___ Poultry ___ Sheep ___ Other

2. How many years have you lived in Clearwater County? __________

3. Is your home in Clearwater County your primary place of residence? Please check **one**.

______Yes

______ No

4. In what year were you born? **19**__________

5. What is your gender? Please check **one**.

______ Female

______ Male

6. Which of the following age categories do the people living in your house fall into? Please check **each** category that applies.

________ 17 or Younger

________ 18 to 29

________ 30 to 49

________ 50 to 69

________ 70 or Older

7. In which of the following activities do you consider yourself to be an active participant? Please check **each** activity that you participate in.

________ Ranching ________ Hunting ________ Cougar hunting

________ Outfitting/Guiding ________ Hiking/Backpacking ________ Horseback riding

________ Camping ________ Canoeing ________ Wildlife photography

________ Fishing ________ Trail Running ________ Wildlife viewing

Section 1: Background Information.

8. In which of the following types of organizations are you an active member? Please check **each** type of organization you participate in.

________ Hunting organization (FNAWS, Alberta Fish & Game, APOS, Hunting for Tomorrow, etc.)

________ Conservation organization (Alberta Wilderness Association, Canadian Parks and Wilderness Society, Sierra Club, etc.)

________ Outdoor activity club (ski club, hiking club, etc.)

________ None of the above

9. What is your highest level of formal education? Please check only **one** of the following.

________ 11 years or less
________ High school diploma or equivalent
________ 1-3 years of college or university
________ 4 or more years of college or university

Section 4: Cougar Management.

22. Potential human-cougar interactions are described below. Which response would you prefer the authorities took under each situation?
For **each** row below, please check **every** action that you find acceptable.

	Take no immediate action	**Provide education on cougar safety**	**Try to frighten the cougar away with rubber bullets**	**Try to capture and collar the cougar for long-term monitoring**	**Try to capture and relocate the cougar**	**Destroy the cougar**
Someone reports seeing a cougar						
A cougar has killed a pet						
A cougar has killed livestock						
A cougar has stalked a person						
A cougar has injured or killed a person						

Section 3: Co-Existence.

18. How likely do you think each of the following situations are? For **each** row below, please circle **one** number.

	Very Likely		Somewhat Likely		Unlikely	Not Applicable
	1	2	3	4	5	6
Encountering a cougar near your home	1	2	3	4	5	6
Being attacked by a cougar near your home	1	2	3	4	5	6
Your pet(s) being attacked by a cougar near your home	1	2	3	4	5	6
Your livestock being attacked by a cougar	1	2	3	4	5	6

19. For residents of Clearwater County, both driving in a vehicle and co-existing with cougars present risks. Would you consider the risk of driving in a vehicle higher, lower or about the same as the risk of co-existing with cougars? For **each** row, please check **one** box.

	LOWER risk	About the SAME risk	HIGHER risk	Not Sure
For yourself				
For your children				

20. Do you think the people who benefit from having healthy cougar populations in Alberta are the same as those who assume the risk of co-existing with cougars? Please check **one** answer

_____ Yes

_____ No

21. Do you think the benefits of having cougars in Alberta outweigh the risks of co-existing them? Please check **one** answer

_____ Yes

_____ No

Section 2: Personal Experience and Perception of Cougars.

10. There are many opportunities for people to learn about cougars. Please indicate if you have had positive or negative exposure to cougars from the following sources. For **each** row below, please check **one** box.

	Positive exposure	Negative exposure	Both positive and negative	No exposure
Your own personal interactions with a cougar				
Someone relating a story of an interaction with a cougar				
From a public presentation about cougars				
Media (newspaper, TV, internet) reports about cougars				
Read a book about cougars				

11. For each of the following statements, please indicate to what extent you disagree or agree. For **each** row below, please circle **one** number.

	Strongly Agree				Strongly Disagree	Unsure
	1	2	3	4	5	6
The presence of cougars is a sign of a healthy environment	1	2	3	4	5	6
It is important to me that cougars persist in Alberta for future generations	1	2	3	4	5	6
It is important to me to know that cougars exist, even if I never see one in the wild	1	2	3	4	5	6
The presence of cougars **in Alberta** increases my overall quality of life	1	2	3	4	5	6
The presence of cougars **near my home** increases my overall quality of life	1	2	3	4	5	6

Section 2: Experience and Perception.

12. Do you think that cougars commonly use areas within ________ of your home? Please check **one**.

_____100 meters
_____500 meters
_____1 kilometer
_____5 kilometers
_____More than 5 kilometers
_____They do not occur within 5 km of my home

13. Do you think the cougar population in Alberta should…? Please check **one**.

____Increase
____Stay about the same
____Decrease

14. Do you think the cougar population within 1km of your home should…? Please check **one**.

____Increase
____Stay about the same
____Decrease

15. Overall, would you consider your feelings towards cougars positive, negative, or neutral? Please check **one**.

_____ Positive
_____ Negative
_____ Neutral
_____Unsure

Section 3: Questions on Human Co-Existence with Cougars.

16. Cougars and humans are increasingly living in the same landscapes. Three different types of communities are listed below. Do you think that cougars and humans should co-exist in…. For **each** row below, please circle **one** number.

	Strongly Agree ←				→ Strongly Disagree	Unsure
	1	**2**	**3**	**4**	**5**	**6**
Rural residential areas (such as the eastern portion of Clearwater County)	1	2	3	4	5	6
Communities located in provincial or national parks (such as Banff or Jasper)	1	2	3	4	5	6
Urban areas (such as Calgary or Red Deer)	1	2	3	4	5	6

17. Recent regulation changes in Alberta now allow people to shoot a cougar on their property on sight. Do you think it is appropriate to shoot a cougar if…..
For **each** row below, please circle **one** number.

	Strongly Agree ←				→ Strongly Disagree	Unsure
	1	**2**	**3**	**4**	**5**	**6**
You saw a cougar on your property, but away from your home?	1	2	3	4	5	6
You saw a cougar near your home?	1	2	3	4	5	6
A cougar threatened you or another person?	1	2	3	4	5	6
A cougar threatened a pet?	1	2	3	4	5	6
A cougar threatened livestock?	1	2	3	4	5	6