

# Human-Cougar Interactions: A Literature Review Related to Common Management Questions

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# Minimizing human-cougar interactions is a management priority for wildlife agencies in western North America



## The problem

- Maintaining viable cougar populations is important because cougars are an apex predator whose presence helps to shape ecosystem composition and function through the top-down effects of predation (Ray et al. 2005) and because the public values the diverse and intrinsic benefits cougars provide (Duda et al. 2002).
- However, cougars can also present a risk to public safety and private property because spatial and temporal overlap with people can lead to negative interactions resulting in the need for an agency response and/or management action

# Review overview

- They assessed both the analytical and ecological merits of current literature, focusing on data and methods, to summarize the current state of knowledge on human-cougar interactions and factors affecting these interactions.
- They did not use their review findings to provide management recommendations or evaluate/suggest policy alternatives, but we did highlight important information gaps, research needs, and proposed strategies for conducting scientific investigations to benefit managers and policy makers in the future.
- They evaluated 41 studies that aligned with eight commonly asked questions regarding how various factors contribute to cougar proximity to, and interactions with people. 1) the questions allowed them to organize a large and potentially disparate body of information around specific unifying topics with direct management applications and, in a way that should increase their utility for Fish and Wildlife Commission members, WDFW policy makers, and the interested public.

# 8 Key questions assessed – all answers still under research and have uncertainty.

1. Do cougar removals through recreational hunting and/or agency conflict response affect the number or probability of cougar-human interactions?
2. Does the size (N or density) or trajectory of a cougar population affect cougar-human interaction levels?
3. Does the abundance, diversity, and/or distribution of natural prey affect cougar-human interaction levels?
4. Do preventative measures, such as nonlethal deterrence, quality husbandry, and outreach/education/information sharing affect the frequency of cougar interactions with people?
5. Do landscape characteristics (e.g., residential development levels and/or patterns, habitat type, connectivity) affect cougar-human interaction levels?
6. Does the number of people living, working, or recreating in cougar habitat affect the number of cougar-human interactions?
7. Is the number of conflict reports/complaints correlated with actual frequency of conflicts (*i.e.*, is there published evidence that, with no change in real conflict, complaints may increase because of social tolerance or change in human perceptions [e.g., trail or doorbell camera use, news reports, etc.])?
8. Does the presence of other large carnivores, notably wolves, affect cougar proximity to, or the frequency of interactions with, people?

# Review findings

- Their review concluded that the roles of cougar removals (Question 1), cougar population size or trajectory (Question 2), the abundance or diversity of prey (Question 3), human population size, distribution, or recreation levels (Question 6), human attitudes (Question 7), and competition with other large carnivores (Question 8) in cougar interactions with people remain uncertain.
- The studies evaluating the efficacy of nonlethal deterrents (Question 4) provided some evidence that these methods reduce conflict, most notably that flashing lights can reduce interactions in specific situations.
- Review of papers investigating the role of landscape characteristics (Question 5) revealed spatial ecology to be the most reliably studied and best understood facet of cougar wildland-urban ecology; study designs in these investigations were also the most rigorous.
- Most cougar use, and subsequent interactions with people, occur at the wildland-urban interface or in exurban and rural residential settings immediately adjacent because these habitats provide both abundant native prey (deer) and stalking cover, or they retain enough native landcover, connectivity, and prey to support cougar use, but with a human presence at a level that does not substantially deter cougars.

# Research needs

- They identified only a limited number of informative studies in their review, primarily because many studies did not collect data to specifically address relevant management questions after developing testable hypotheses. Much of the literature we reviewed was derived from *ad hoc* mining of pre-existing data that had been collected for other routine reasons, data were often not assessed for accuracy, and confounding factors were inadequately addressed. Consequently, many factors theorized to contribute to cougar interactions with people require more rigorous investigation.
- Because wildland-urban systems are complex, and interactions encompass both human and cougar behavior, they recommended the use of long-term studies that incorporate both ecological and anthropogenic factors within a control-treatment design with replicate study sites to address questions with direct management relevance.

# “Errors” in research

- In general, detecting statistically significant ecological effects in research is easier when the magnitude of effects is large, and/or sample sizes are large, and/or chance variability in the data is modest. When any of these are not true, and especially when all of these are not true, it is challenging to generate powerful hypothesis tests, and reliable knowledge remains elusive.
- Researchers are generally trying to avoid 2 undesirable outcomes:
  - 1) concluding that important differences or relationships exist, when in fact they do not, or
  - 2) concluding that differences and/or relationships do not exist, when they really do. Both are errors, and both muddy attempts to advance our understanding.

# Challenges to cougar research

- Cougars are a relatively low-density, solitary, and secretive carnivore with a complex social organization: female space-use is primarily driven by access to prey for rearing offspring and male space-use reflects the maintenance of large, semi-exclusive territories providing access to several breeding-age females (Logan and Sweanor 2009).
- Consequently, gathering data from enough individual cougars to make statistical inferences about populations with a sufficient level of certainty (i.e., statistical power) requires working across a large area for an extended period (typically, a minimum of 1,500 km<sup>2</sup> for  $\geq 5$  years). This is labor-intensive, expensive, logistically difficult, and frequently prevents the use of replicate study areas.
- Manipulating a cougar population for either intentional decline or growth is often controversial despite that it may provide valuable experimental controls and strengthen scientific inference; thus, not infrequently, researchers must employ less powerful observational methods.



*Question 1 – Do cougar removals through recreational hunting and/or agency conflict response affect levels of cougar-human interaction?*

7 papers

- Conclusions embodied in these papers about effects of harvest or agency removals on cougar-human interactions were inconsistent across papers, and often equivocal and not well supported
- The impact of removals remains unknown.

## *Question 2 - Does cougar abundance or population trajectory affect cougar-human interaction levels? (5 studies)*

- The five studies had inconsistent results. 3 studies found a positive relationship, one found a negative relationship and one found no relationship.
- Kertson and Keren (2021) yielded 2 key takeaways relevant to Question 2: 1) a growing cougar population does not necessarily translate into a greater number of interactions because the increased growth rate manifested primarily as subadults with a propensity to emigrate outside of the residential/wildland interface study area to the larger wildland matrix rather than recruiting to the study population and, 2) the effects of cougar population size or trajectory are likely mediated or mitigated by other ecological and anthropogenic factors (e.g., the distribution and abundance of people and prey).

### *Question 3 - Does the abundance, diversity, and/or distribution of prey affect cougar-human interaction levels? (2 papers)*

- The two studies provided few reliable insights
- Polisar et al. (2003) provided descriptive evidence that cougars preyed upon domestic livestock on cattle ranches in Venezuela when wild prey were readily available.
- It is, however, worth noting that each study demonstrated that cougars in wildland-urban environments routinely eat ungulates and other prey species associated with people, but domestic species constitute a small proportion of cougar diets.
- Although we identified only 2 papers directly relevant to Question 3, it is important to recognize there is a more expansive body of literature on cougar diet and foraging ecology in wildland-urban landscapes. This literature is largely a product of intensive field studies completed in California (Smith et al. 2015, 2016), Colorado (Moss et al. 2016a, 2016b, Blecha et al. 2018), and Washington (Kertson et al. 2011, Robins et al. 2019) (Appendix 1). Three of these studies focused primarily on the effects of human landscape features on cougar behavior and prey use and were subsequently determined to be more appropriately reviewed within the context of Question 5 (Table 1)

*Question 4 - Do preventative measures, such as nonlethal deterrence, quality husbandry, and outreach/education/information sharing affect levels of cougar interactions with people? (5 papers)*

- These papers provided some evidence nonlethal deterrents can reduce interactions in specific situations.
- The Ohren et al. (2019) paper represented one of the most rigorous studies included in this review. They used a randomized, 2×2 crossover design to demonstrate that flashing lights (i.e., Foxlights®) reduced depredations on alpaca (*Vicugna pacos*) and llama (*Llama glama*) within the Tarapaca region in the altiplano of Chile. The crossover design provides an excellent framework for exploring cause-effect relationships. This study had only minor shortcomings; however, unique animal husbandry practices and landscape characteristics of the study area (e.g., elevation > 3,000 m, plains) may limit the applicability of their findings to other ecosystems

# Aversive conditioning needs to be proactive not reactive to be effective and occur before food rewards are gained.

- Alldredge et al. (2019) is its identification of important logistical considerations for hazing cougars and their recommendation that future research investigations apply treatments proactively, rather than reactively, to avoid cougars receiving food rewards that may undermine treatment effects.
- The work of Alldredge et al. (2019) was fundamentally different than the other studies related to this topical question. First, Alldredge et al. (2019) represented an opportunistic approach that explored the use of aversive conditioning techniques (e.g., rubber bullets, bean bag rounds, and dogs) to prevent individual cougars from returning to residential areas or engage in future depredations of domestic animals embedded within a much larger research effort. With this design, the individual cougar, not the site being treated, represented the sampling unit.

*Question 5 - Do landscape characteristics (e.g., residential development levels and/or patterns, habitat type, connectivity) affect cougar-human interaction levels? (22 papers)*

- spatial ecology is the most reliably studied and best understood facet of cougar wildland-urban ecology.
- Researchers employed diverse quantitative methodologies in their studies that yielded remarkably consistent patterns, relationships, and behaviors.
- Cougar use of areas with residential development is commonplace, but interactions with people occur infrequently relative to the intensity of this use (Kertson et al. 2011, Alldredge et al. 2019). As residential density increases, cougar use decreases (Kertson et al. 2011; Wilmers et al. 2013; Adams-Knopff et al. 2014; Alldredge et al. 2019) and use of highly urban landscapes is rare (Burdett et al. 2010, Riley et al. 2021).
- consistent patterns of greater amounts of forest, increased proximity to wildlands/open space, greater terrain complexity, and fewer houses or greater distance to residential development were consistently associated with increased cougar presence in developed portions of the landscape (Burdett et al. 2010; Kertson et al. 2011; Adams-Knopff et al. 2014; Benson et al. 2016; Jennings et al. 2016; Alldredge et al. 2019; Smith et al. 2019). With the notable exception of distance to residential development, these same landscape features are frequently correlated with the occurrence of cougar-human interactions (

*Question 6 - Does the number of people living, working, or recreating in cougar habitat affect the level of cougar-human interactions? (2 papers)*

- The two papers linked increases in human recreation to cougar encounters but analytical shortcomings and confounding variables prevented accurate determination of a cause and effect relationship between increased human use and conflicts with cougars.

*Question 7 - Is the number of conflict reports/complaints correlated with actual frequency of conflicts (i.e., is there published evidence that, with no change in real conflict, complaints may increase because of social tolerance or change in human perceptions [e.g., trail or doorbell camera use, news reports, etc.]?)?*

- Although this is a legitimate question with relevance to managers, they were unable to locate any published studies focused on or clearly relevant to the question.



*Question 8 - Does the presence of other large carnivores, notably wolves, affect cougar proximity to, or levels of interactions with, people?*

- the presence of wolves in northcentral Washington motivated a shift in cougar activity from night into daylight hours, which increased their potential temporal overlap with people

# Limitations of the review

- The principal shortcoming is that there are very few studies where researchers collected data to specifically address relevant management questions after developing testable hypotheses. Much of this literature is based on *ad hoc* mining of pre-existing data that had been collected for other routine reasons
- The relative scarcity of properly designed studies yielding strong inference in this topic area to date does not mean questions about conflict risks are intractable for research.
- the effects of many of the lethal and nonlethal strategies proposed to reduce risks of cougar interactions with people have not been adequately evaluated.

# A rigorous research approach is needed.

- Cougar research is logistically challenging, expensive, and potentially contentious in any ecological setting,... Consequently, policy makers need to provide sufficient resources, patience, and support to researchers to conduct long-term investigations (i.e., 8-10 years) within multiple study areas to ensure successful application of treatments and the acquisition of sufficient sample sizes.
- The dangers of using data post hoc to answer research questions has been highlighted through this through review of existing literature and research projects. It is obvious that a more rigorous approach to examine cougar-human interaction needs to be implemented to answer the most important questions. Data collection on interaction events must first be standardized across jurisdictions to provide a reliable base to measure interaction strength.