

BRITISH COLUMBIA'S NEGLECTED CARNIVORE

A Conservation Assessment
and Conservation Planning Guide for

COUGARS

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About Raincoast Conservation Foundation:

Raincoast is a team of conservationists and scientists empowered by our research to protect the lands, waters and wildlife of coastal British Columbia. Our on-the-ground presence has given us a deep-rooted understanding of this vast coastline.

Our vision for coastal British Columbia is to protect the habitats, foods, and lives of umbrella species. We believe this approach will help ensure the survival of all species and ecological processes that exist at different scales.

Investigate. Inform. Inspire.

We Investigate to understand coastal species and processes.

We Inform by bringing science to decision makers and communities.

We Inspire people to be ambassadors for, and protectors of, this precious coastline.

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Introduction

BC provides an important opportunity for cougar conservation. At present, however, sufficient ecological information is lacking, which constrains the certainty with which a comprehensive conservation strategy for cougars can be created and implemented. In anticipation of the first provincial conservation plan for cougars, however, British Columbians have a promising opportunity to contribute to cougar conservation and welfare. Raincoast’s vision for cougar-human coexistence in BC is informed by the best available scientific information, an acknowledgement of the uncertainty in information on cougars, and widely-held societal norms about how wildlife should be treated. We believe that most of the public shares similar values regarding safety for human and domestic animals; sustainable livelihoods for BC families and communities; biodiversity conservation; and conservation-based food hunting and logging. We also believe that most British Columbians, including most that participate in food hunting, are concerned about trophy hunting of large carnivores and habitat protection for predators and prey.

Framework

Large carnivores have been declining in North America since the arrival of the first European settlers. The ranges of these species contracted drastically as human civilization advanced farther across the continent. Now, animals like the grizzly bear, gray wolf, wolverine, and lynx survive primarily in the extreme northern regions of the continent, and in rugged wilderness areas in the western mountains. Other large carnivores, like the cougar and black bear, have fared substantially better, yet still represent special management problems. Despite conservation successes in recent years, the long-term prospects for large carnivores throughout North America are poor. Most of these species likely remain on a long-term decline toward extinction.

British Columbia (BC) is one of the last strongholds of these elusive predators. The province holds extensive blocks of large carnivore

Beautiful and mysterious, cougars have persisted against countless and unrelenting threats to retain a substantial foothold in BC.

habitat in remote, rugged places that have endured only limited human impact. These wildlands provide core areas of vital ground for all indigenous wide-ranging carnivores, including cougars. This habitat core has sustained large carnivores while they vanished from most other parts of the continent south of the 49 parallel.

The continued presence of animals like cougars makes BC qualitatively different from most other scenic places. Large carnivores and the lands that sustain them are increasingly cherished as untamed and irreplaceable assets for our increasingly urbanized society. The unwelcome prospect of losing these species, and thereby losing the very wildness of BC, is a cause of great concern and even greater conservation effort. The Raincoast Conservation Foundation has embraced this conservation effort so the prospects for cougars are substantially improved while the opportunity still exists.

Beautiful and mysterious, cougars have persisted against countless and unrelenting threats to retain a substantial foothold in BC. Blessed with abundant wilderness and established cougar populations, BC provides an unparalleled opportunity for the conservation of these big cats. In contrast with many other North American jurisdictions, the province provides a large geographic area and low human density. Importantly, from a conservation perspective, most cougar habitat in BC is in public rather than private land.

Despite this conservation promise, cougars in BC face many problems. They have been subjected, historically and currently, to exploitation and persecution by humans. At present, the BC government, which is responsible for cougar conservation, lacks sufficient ecological data and a contemporary or comprehensive conservation strategy. In addition, current provincial policies are inadequate to protect cougar populations in the long term or ensure the welfare of individuals that constitute the population. Meanwhile, threats are intensifying because human land-use activity is rapidly modifying cougar habitat from its original form in which cougars and their prey coevolved.¹

These promises and threats must be considered within a world-wide context. Our planet is experiencing an ecological crisis in which biodiversity is rapidly being lost. Globally, many felids (members of the cat family) are categorized as vulnerable or endangered (Nowell and Jackson 1996). Likewise, humans have caused the extirpation of other large carnivores across continents, including North America.

¹ Throughout this document, we conform to Hall et al.'s (1997) definition of critical habitat as the measure of an area's ability to provide the resources necessary for the persistence of a population.

Current provincial policies are inadequate to protect cougar populations in the long term or ensure the welfare of individuals that constitute the population.

Accordingly, we offer this report in the context of the ever-growing carnivore conservation movement and, broadly, the global extinction crisis. We consider our efforts as a race against time. Clearly, the best time for ensuring the conservation of cougars is while viable populations and connected habitat still exist (Logan and Sweanor 2001).

If we are to maintain – and ultimately push back – the geographic line of cougar extirpation, difficult decisions on land use and wildlife management will be required. Lasting success will come from securing the spatial and cultural integration of conservation and development goals throughout BC. This inevitably means less intensive and extensive human presence in parts of the province. Changing public values and economic forces over decades, combined with better scientific understanding of cougar populations and habitat requirements, must bring this about. Otherwise, cougars will not survive.

Based on a comprehensive review of cougar ecology, research, and management, our report provides an assessment and framework for a science- and ethics-based conservation plan. Importantly, we incorporate contemporary scientific information, best principles in conservation science, and a contemporary environmental ethical perspective related to human-carnivore relationships. We also compare cougar research and management in BC with other areas where cougar populations persist. Significantly, we believe that *humans* who live, recreate, and exploit biological resources within cougar distribution also ought to be managed.

Our report also provides an evaluation of current provincial management policies. We specifically ask whether these policies are adequately protecting BC cougar populations and habitat and respecting the welfare of individuals within those populations. We provide recommendations for a long-term conservation strategy and, based on our analysis of knowledge gaps in BC, recommend several urgent research priorities.

In anticipation of the first comprehensive conservation plan designed for cougars by the Ministry of Environment, British Columbians have a promising opportunity to contribute to cougar conservation and welfare. At present, no management plan exists, although a preliminary plan was prepared in 1980 and another drafted in 2005 (BC Fish and Wildlife 1980; Austin 2005). Consequently, BC manages cougars without a central planning document, ostensibly relying on hunting regulations to safeguard populations (Austin 2003).

Blessed with abundant wilderness and established cougar populations, BC provides an unparalleled opportunity for the conservation of these big cats.

In contrast, Alberta adopted a management plan for cougars in 1992 (Alberta Forestry, Lands and Wildlife 1992). Remarkably, the annual budget for cougar management in BC was estimated at only \$12,000. These funds were used primarily for the inspection of dead cougars (Atkinson 1997). Clearly, this can be improved.

We expect that our recommendations will be considered in the upcoming planning processes. Accordingly, we offer this report respectfully as a frame of reference, not a blueprint or prescription. Importantly, our report builds a foundation for longer-term, larger-scale research, informed advocacy, and educational outreach throughout cougar distribution in BC, and on Vancouver Island in particular. We aim to inform the public and decision-makers about opportunities for conservation science and environmental ethics to be integrated into BC management and policy. The program set forth is our tentative assessment of what needs to happen to improve the future prospects of cougars in BC. We propose goals and measures, targets, and steps needed to set targets, and identify some of the conservation tools for the job ahead.

Vision and philosophy

Wildlife conservation has entered a new era of political debate, reduced public funding, and diminished options. Survival of cougars and the biological communities that sustain them depends on the ability of wildlife managers, conservationists, scientists, and citizens to adapt to these changing circumstances. In general, Raincoast advocates for environmental sustainability on a bioregional scale based on an ethical relationship between people and place. Our long-term goal is to maintain viable populations of cougars, genetically linked with populations in other regions. The strategy is structured around maintaining and restoring habitat, including a network of protected areas; integrating multi-species management efforts outside protected areas; and encouraging sustainable development options for rural communities, including incentives for cougar conservation. A prerequisite for success throughout is to build cooperative partnerships with government managers, First Nations, outdoors people, hunters, rural communities, ranchers, and private owners of large land holdings.

Our approach is based in science, reflecting the emerging wisdom of conservation biologists, whose insights can be traced to the seminal

Based on a comprehensive review of cougar ecology, research, and management, our report provides an assessment and framework for a science- and ethics-based conservation plan.

studies of island biogeography, and who are now applying their knowledge to landscape design and regional land use planning. Key to this approach is our recognition that if the conservation of cougars is to progress, we must not only focus attention on remaining pristine areas, but also consider the human use of the land that is not strictly ‘wild’. The challenge is to sustain the natural environment and meet human needs by reducing the potential for one to encroach seriously upon the other. This reality leads our strategy to move beyond its scientific moorings to address pragmatic issues such as economic needs and conflicts that inevitably arise between humans and large predators. At present, the fate of cougars is more closely tied to sociology than biology.

Cougar conservation is more than a scientific puzzle; it is also a socioeconomic challenge that requires action to reconcile human and cougar needs. Our vision for cougar-human coexistence is founded on a moral framework that is informed by the best available scientific information. In support of cougar conservation and welfare, our philosophy is to seek understanding and common ground among all those concerned with cougars. In our view, however, unreasonable compromise among special interests risks failing humans and cougars. Livelihoods and conservation, for example, need not come in conflict if we value both.

Few conservation challenges demand as much innovation and cooperation as the conservation of large carnivorous mammals. Low densities, large home ranges, and the secretive nature of species like cougars complicate research efforts. The extensive spatial requirements of these species and their potential to clash with human activities generate socio-political conflicts that span political borders and agency mandates. Therefore, conservation strategies for large carnivores must be designed to work at local, regional, and international scales through cooperative mechanisms.

Long-term conservation of all large carnivores will ultimately depend on healthy human communities accepting and supporting conservation programs. Thus, Raincoast emphasizes the needs of human communities, and not only the need to maintain large carnivore habitat. Although continued survival of large carnivores holds great scientific, cultural, economic, and spiritual benefits for people, the cost of conserving these species often falls disproportionately on disadvantaged rural communities. Innovative and equitable ways

Our report builds a foundation for longer-term, larger-scale research, informed advocacy, and educational outreach throughout cougar distribution in BC, and on Vancouver Island in particular.

to share the benefits and costs of carnivore conservation will be key components of this long-term effort.

Inferring from several polls on the public's perception of other carnivores, we believe that most British Columbians support cougar conservation. We believe that most of the public shares similar values regarding safety for human and domestic animals; sustainable livelihoods for BC families and communities; biodiversity conservation; and conservation-based food hunting and logging. We also believe that most British Columbians, including most that participate in food hunting, are concerned about trophy hunting of large carnivores and habitat protection for predators and prey.

Importantly, this document is not an argument against the idea that the lethal control of cougars is sometimes appropriate. Nor is this document an argument against hunting in general. Although we oppose cougar hunting in BC, we accept that lethal control is on some occasions appropriate for reducing conflicts that arise between humans and cougars. Indeed, such activities might spare the lives of additional cougars or humans. Our intent, however, is not to assess what conditions are appropriate for lethal control, although careful scrutiny of this issue would be valuable.

Origins, Taxonomy and Distribution

BC's cougar population is a remnant of a once larger network of cougars distributed across North and South America.

Origins and taxonomy

Puma concolor (Linnaeus, 1771)

ORDER: Carnivora

FAMILY: Felidae

Cougars (also known as pumas, mountain lions, catamounts, and Florida panthers) are a large cat species that evolved about 390,000 years ago in South America. Based on recent genetic assessment, cougar populations can be divided into 6 subspecies occurring primarily in mountainous regions of western America from BC to southern Argentina (Culver et al. 2000). Thirty-two (32) subspecies were previously classified using morphological methods. Consequently, classifications remain unsettled as taxonomists continue to debate subspecific designations. According to Culver et al. (2000), only one subspecies occurs across BC and throughout North America. The authoritative Integrated Taxonomic Information System (ITS) lists *P. concolor coryi* as invalid and *P. concolor couguar* as valid (<http://www.itis.gov/index.html>).

Distribution and conservation status

Ranging from the tip of Chile (Patagonia) in the south and across North America from the Pacific to the Atlantic, cougars cover a wider range of latitude than any other wild felid. Until the 1800s, when extensive persecution and subsequent extirpations of cougars began, these cats had the widest distribution of all non-human terrestrial mammals in the western hemisphere (Logan and Sweanor 2001). In North America, cougars are now primarily distributed within

western Canada, western United States, Mexico, and Florida (Pierce and Bleich 2003). The historic Canada/US range has been reduced by more than 50%. Notably, these large cats have been nearly extirpated in eastern North America due to hunting, lethal control, and loss of habitat (Cougar Management Guidelines Working Group 2005).

The United States and International Union for Conservation of Nature (IUCN) list two subspecies *P. concolor coryi*, the Florida Panther, and *P. concolor cougar*, the Eastern Cougar, as ‘critically endangered’.² The parent species, *P. concolor*, is listed as ‘Near Threatened’³ (Wilson and Ruff 1999; Wilson and Reeder 2005; *Table 1*).

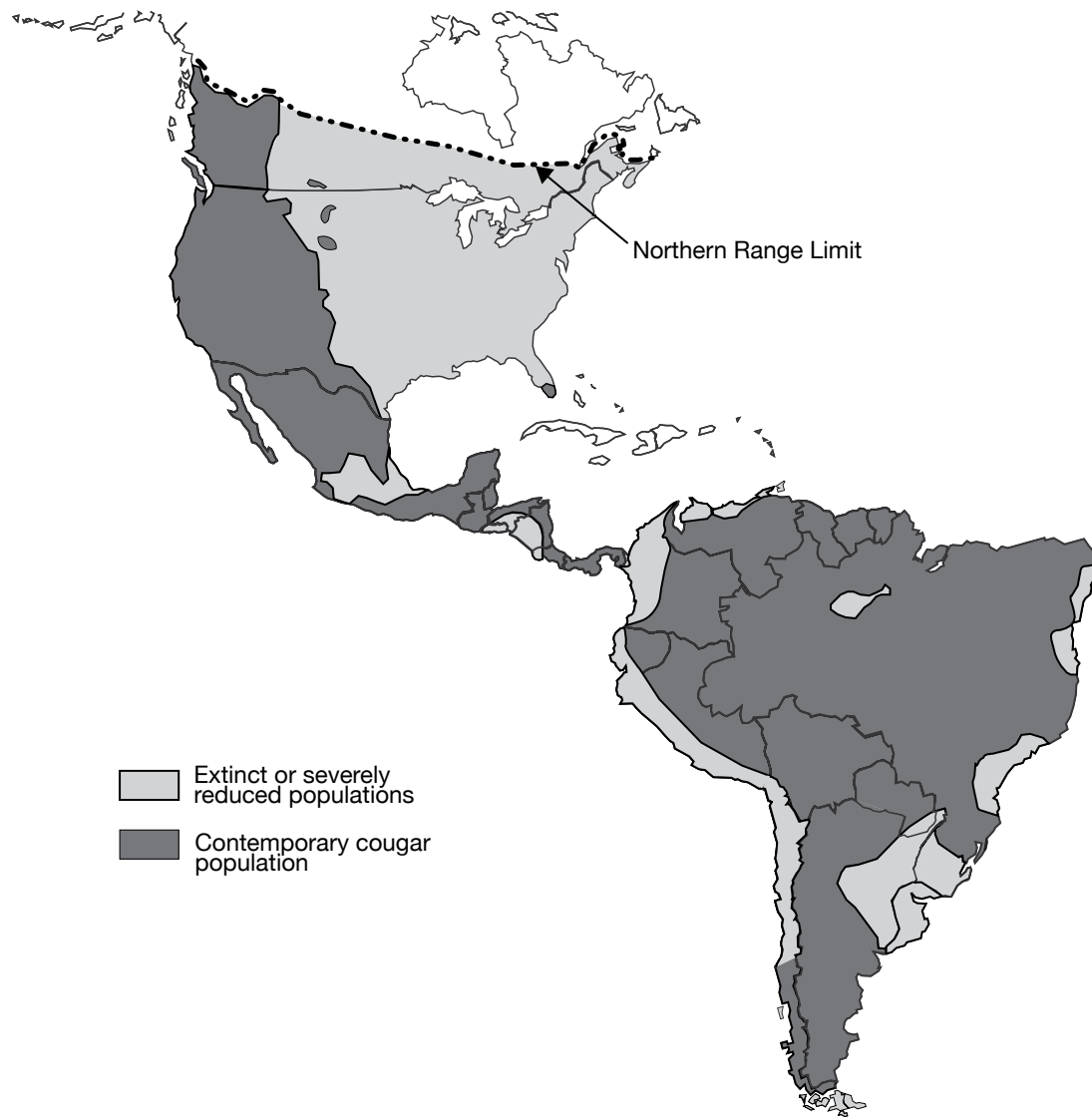
There are 2 distinct populations of cougars in Canada, 1 in the east, which is endangered and possibly extirpated, the other in the west, which is not endangered. Owing to extirpation in many parts of the country, the provinces of BC and Alberta harbour virtually the entire population of cougars in Canada. Here the species appears to occupy more or less all of its historic range. BC’s cougar population is a remnant of a once larger network of cougars distributed across North and South America (*Figure 1*). Although cougars in BC are at the northern extreme of the species distribution, cougars occur sporadically throughout other Canadian provinces and territories (BC Fish and Wildlife 1980; Mulders et al. 2001).

- 2 A species or other taxonomic group facing an extremely high risk of extinction in the wild (see IUCN, Extinct, and Red List).
- 3 A species or other taxonomic group likely to become Critically Endangered, Endangered, or Vulnerable in the near future. (see IUCN, Extinct, and Red List).

Table 1. Conservation Status (Wilson and Reeder 2005).

Status	CITES – Appendix I as <i>Felis. c. coryi</i> , <i>F. c. costaricensis</i> , and <i>F. c. cougar</i> ; otherwise Appendix II; U.S. ESA – Endangered as <i>F. c. coryi</i> , <i>F. c. costaricensis</i> , and <i>F. c. cougar</i> ; U.S. ESA – Similarity of Appearance to a Threatened Taxa (Florida); IUCN – Critically Endangered as <i>P. c. cougar</i> and <i>P. c. coryi</i> , otherwise Near Threatened.
Comments	Reviewed by Currier (1983) as <i>Felis concolor</i> . Placed in <i>Puma</i> by Pocock (1917a), Weigel (1961), Hemmer (1978), and Kratochvíl (1982c). Synonyms allocated according to Culver et al. (2000).

Figure 1. Global cougar distribution (Hornocker and Negri 2010).



Spatial Ecology

BC cougars likely exist in a metapopulation and source-sink structure. Conserving cougars often amounts to conserving deer populations and habitats.

Dispersal

Dispersal of subadults that reproduce outside their natal home range is important to cougar biology and conservation. Dispersal occurs when subadults – approximately 10-30 months old – leave the boundaries of the home range in which they were born (Logan and Sweanor 2001; Cougar Management Guidelines Working Group 2005). Subadult siblings have sometimes been observed dispersing together (Ross and Jalkotzy 1992; Logan and Sweanor 2001). Males disperse over longer distances than females. This long-distance dispersal by males is thought to be obligatory, even at low population densities (Sweanor et al. 2000; Logan and Sweanor 2001). If subadult females do disperse, they usually do so over shorter distances (Sweanor et al. 2000; Logan and Sweanor 2001). Otherwise, based on genetic and radiotelemetry data, females have been shown to have philopatric (remaining in one's birthplace) matrilineal relationships in which related females occupy overlapping and adjacent home ranges (Ross and Jalkotzy 1992; Sweanor et al. 2000; Hahn 2001; Logan and Sweanor 2001; Loxterman 2001; Clarke 2003). Importantly, philopatric females are able to raise their families in home ranges in which they are familiar with such resources as prey and nursery sites (Logan and Sweanor 2001).

Home range and movement through landscapes

Cougars are generally solitary animals, though notable exceptions include mating pairs, females accompanying kittens, and subadult siblings dispersing together. Families consist of mothers and their kittens (Seidensticker et al. 1973; Logan and Sweanor 2001; Pierce and

Bleich 2003). Whereas males are territorial, females do not aggressively exclude others from their home ranges. Moreover, females will sometimes shift their home ranges to accommodate other related females (Logan and Sweanor 2001).

Adult males mate with females that live within their home ranges and generally have larger home ranges than adult females (Logan and Sweanor 2001). Female home ranges become larger as the females and their kittens age, but are largest when females have no kittens (Spreadbury 1989; Ross and Jalkotzy 1992; Hahn 2001; Logan and Sweanor 2001).

Cougars are thought to have a sophisticated multi-sensory system of communication by which they maintain spacing among themselves. Scent marking is one means of visual and chemical communication (Hornocker 1970; Seidensticker et al. 1973; Logan and Sweanor 2001). These scrape sites are thought to function as ‘bulletin boards’ that cougars visit to assess presence, reproductive status, and individual identity of other cougars (Logan and Sweanor 2001). Cougars often urinate on scrape sites and mark them with scat (Hornocker 1970; Seidensticker et al. 1973; Logan and Sweanor 2001; Shaw et al. 2007). Such sites are generally created by adult males, although adult females also visit them (Seidensticker et al. 1973; Logan and Sweanor 2001; Shaw et al. 2007). Mothers are thought to reduce the risk of injury or death to themselves and their kittens by not revealing their presence via scrape sites to adult males. Females in oestrus, however, may use scrape sites to signal their availability to mate (Logan and Sweanor 2001). In addition, cougars sometimes scratch the bark of deciduous trees. These scratch trees are likely used for claw grooming, although they might also form part of the larger communication system (Logan and Sweanor 2001).

Metapopulation and source-sink structure

The metapopulation concept is useful for understanding how cougars are affected by hunting and habitat fragmentation. A metapopulation is a ‘constellation’ of subpopulations (Hanski 1999; Sweanor et al. 2000). For metapopulations to persist over time, genetic exchange must occur among subpopulations. This usually occurs via dispersers that successfully reproduce after re-establishing in a new location. Many studies have demonstrated that cougar populations exhibit a

metapopulation structure in which subpopulations occupy habitat patches that are separated by non-cougar habitat and connected by dispersing subadults (Sweanor et al. 2000; Logan and Sweanor 2001; Cougar Management Guidelines Working Group 2005). Research, however, suggests that some cougar populations are not structured as metapopulations, but instead as panmictic megapopulations, meaning they are not structured spatially (Andersen et al. 2004). Perhaps many cougar populations were originally panmictic and humans have forced them to adapt to a metapopulation structure.

Within a metapopulation framework, cougar populations can consist of ‘source’ and ‘sink’ subpopulations. Whereas sources provide dispersing subadults to other subpopulations, sinks can contribute to the overall decline of a regional population. To avoid extirpation, a sink population must be connected to a source population or it will ‘wink out’ over time (Logan and Sweanor 2001; Cougar Management Guidelines Working Group 2005).

BC cougars likely exist in a metapopulation and source-sink structure. Given tremendous ecological and physiographical heterogeneity and potential topographical barriers, we would predict a comparatively structured population in the province. At present, however, BC cougar populations are managed within regions and management units defined by administrative boundaries, as opposed to known ecological discontinuities, which do not necessarily account for their possible metapopulation and source-sink structure. We suggest that cougar management units ought to conform to natural spatial structures (metapopulation or other), rather than jurisdictional boundaries (Cougar Management Guidelines Working Group 2005). This would require province-wide genetic assessment to determine structure, which is feasible using samples provided by hunters.

Cougar and prey habitat

Cougar habitat is varied, but known preferences exist. They can occur at all elevations but prefer mixed wood and coniferous vegetation. They use a mosaic of habitat types that correspond to different seasons, age classes, and sexes. Individual home ranges often change spatially over time (Seidensticker et al. 1973; Logan and Sweanor 2001). In southeastern BC, for example, cougars used lower elevations during winter and higher elevations in summer, likely following prey

between seasonal home ranges (Spreadbury 1989; Katnik 2002; Clarke 2003). Cougars in the eastern front ranges of the Canadian Rocky Mountains (southcentral Alberta) showed a trend in distribution from higher elevation and less rugged terrain in December, to lower elevation and more rugged terrain in March (Alexander et al. 2006).

Cougars are closely tied to deer species as their main prey so that conserving cougars often amounts to conserving deer populations and habitats. Habitat for cougars can occur at multiple spatial scales, each relating to specific life history requirements. As noted above, habitat use varies among locations and among individuals (Katnik 2002). In Alberta, at a large spatial scale, high quality cougar habitat included lower elevations, increased terrain ruggedness, denser vegetation cover, and a secure distance from high-use human areas that varies with physiography (Jalkotzy et al. 2003). In southeastern BC, Washington, and Idaho, cougars located their annual home ranges in rugged terrain and selected for steep slopes within their winter home ranges (Katnik 2002).

At a smaller spatial scale, habitat use varies according to the area and activity for which it provides utility. Riparian areas, ridgelines, and environments that provide horizontal cover with comparatively gentle topography are often favoured. Roads are used, but paved surfaces are typically avoided (Beier 1995; Gladders 2003; Dickson et al. 2005). Settings where predation occurs – stalking, capturing, caching, and feeding – can occur in different environments (Katnik 2002). Stalking cover can be in dense vegetation and/or rugged topography (Hansen 1992), but at least in California, captures occur in open habitat (Pierce et al. 2004). On northeastern Vancouver Island, feeding sites were located in areas of denser horizontal cover (Gladders 2003). At the smallest spatial scale, a series of nursery sites where mothers nurse kittens, often less than 200 m from one another, are located in rocks, holes, and vegetation (Beier 1995; Logan and Sweanor 2001). We suspect that, in BC, cougars might also use old-growth trees for nursery sites.

Multi-predator and Multi-prey Systems

As a keystone species, cougars play important roles in their ecosystems. Keystone species enrich ecosystem function in a unique and significant manner; their effect is disproportionate to their numerical abundance. BC cougars form part of complex multi-predator-multi-prey systems that should be considered in their conservation and management.

Multi-predator systems

Cougars in BC generally form part of complex multi-predator-multi-prey ecosystems. This is important to the conservation and management of cougars because they interact with other predators. Consequently, understanding the influence of cougar predation on prey requires consideration of other predators (Kunkel et al. 1999; Pierce and Bleich 2003; Cougar Management Guidelines Working Group 2005). Wolves, coyotes, black bears, and grizzly bears have been documented displacing cougars from feeding sites, and chasing, treeing, and killing cougars (Harrison 1989; White and Boyd 1989; Boyd and Neale 1994; Gladders 2003; Ruth et al. 2005; Kortello et al. 2007).

Keystone species

As a keystone species, cougars shape the ecology and evolution of plants and animals within their shared ecosystems (Logan and Swenor 2001). A keystone species is one whose influence on its community or ecosystem is disproportionately large relative to its abundance (Power et al. 1996). Ecosystem structure and function are negatively affected by the extirpation of a keystone species (Sinclair and Byrom 2006). Importantly, the process of predation maintains biodiversity (Terborgh et al. 1999; Miller et al. 2001). Large carnivores can prevent prey from becoming overabundant, thereby reducing the

overbrowsing and overgrazing of plants (Terborgh et al. 1999; Miller et al. 2001). When large carnivores are extirpated, ecosystems can lose biodiversity. In Utah and California, Ripple and Beschta (2006, 2008) suggested that increased numbers of human visitors to 2 protected areas reduced cougar abundance, which in turn increased deer abundance and browsing of plants that consequently reduced biodiversity.

Cougar-prey relationships

As a keystone species, cougars shape the ecology and evolution of plants and animals within their shared ecosystems.

Cougars are opportunistic predators, although ungulates provide most of their prey biomass (Logan and Sweanor 2001; Bauer et al. 2003; Cougar Management Guidelines Working Group 2005). They are ambush predators that often stalk their prey (Pierce et al. 2000; Cougar Management Guidelines Working Group 2005). Notably, individual cougars may learn to specialize on prey such as bighorn sheep (Ross et al. 1997; Ernest et al. 2002; Festa-Bianchet et al. 2006). In addition, cougars are opportunistic foragers and thus some events perceived as predation may actually be scavenging (Pierce et al. 1998; Nowak et al. 2000; Bauer et al. 2003). In New Mexico, for example, cougars scavenged 9% of radio-collared deer that died from non-predation causes (Logan and Sweanor 2001).

Cougars in BC live in multi-prey systems that should be considered in their conservation and management. They prey on a variety of species, including deer, elk, moose, snowshoe hares, rabbits, raccoons, grouse, bighorn sheep, mountain goats, porcupines, beaver, marmots, and caribou (Spalding and Lesowski 1971; Spreadbury 1989; Harrison 1990; BC Fish and Wildlife 1994; BC Ministry of Water, Land and Air Protection 1996; Kunkel and Pletscher 1999; Kinley and Apps 2001; Katnik 2002; Gladders 2003; Wittmer 2004; Bryant and Page 2005; Wittmer et al. 2005). In addition, we suspect that some BC cougars use marine resources, including salmon and other species scavenged in intertidal zones. Finally, the distributions and abundances of some prey species are changing in BC. As a consequence, relationships previously documented between these cats and their prey might be modified, sometimes substantially. For example, white-tailed deer and moose are entering previously unoccupied habitat or increasing in numbers within known habitats.

Coupled population dynamics of cougars and their prey

Predator-prey dynamics are often coupled. Top-down (i.e., predation) and bottom-up (i.e., nutrient inputs to plants) processes act simultaneously on ecosystems (Terborgh et al. 1999; Logan and Sweanor 2001; Bowyer et al. 2005). Importantly, estimates of predation rates and proportions of prey populations killed do not adequately describe the influence of cougar predation on prey populations. This is because predation rates do not account for the effects of additive or compensatory mortality and whether regulation is top-down or bottom-up (Bowyer et al. 2005; Cougar Management Guidelines Working Group 2005).

Prey population density relative to carrying capacity is important. Carrying capacity is the population size of the species that the environment can sustain indefinitely, given the food, habitat, water, and other necessities available in the environment. This relationship between prey population density and carrying capacity determines whether regulation is stronger from above or below and whether mortality is compensatory (those killed by predators would have died due to other causes) or additive (those killed by predators are in addition to those killed by other factors). In theory, at carrying capacity mortality factors are compensatory and below carrying capacity they are additive (Ballard et al. 2001). However, mortality factors generally occur along a continuum between the two (Kunkel and Pletscher 1999; Ballard et al. 2001; Logan and Sweanor 2001). The influence of predation is greater when mortality due to predation is additive to other types of mortality and less when compensated for by reductions in other types of mortality or increases in recruitment. If individuals in an ungulate population are in poor physical condition, cougar predation likely has little effect on prey abundance. Conversely, when individuals are in excellent condition, cougar predation may have a large effect on prey abundance (Cougar Management Guidelines Working Group 2005). Importantly, even if cougar predation is the primary proximate limiting factor and slows the increase of prey, a prey population can still grow to carrying capacity (Logan and Sweanor 2001; Pierce and Bleich 2003). Without cougars (or other predators), however, the ecological consequences for prey are clear. Typically, prey

populations will grow at a faster rate and to higher numbers before becoming limited by food (Logan and Sweanor 2001).

Some wildlife managers and hunters fear that cougars might indefinitely continue to increase and drive ungulate prey to increasingly low levels. This is not likely. Although cougar abundance may continue to increase initially if a prey population declines, cougar abundance will also decline after a period if no alternative prey are available (Logan and Sweanor 2001; Cougar Management Guidelines Working Group 2005). Notably, some biologists have suggested that recently documented small litter sizes among Vancouver Island cougars might be due to a declining deer population on the island (Wilson et al. 2004). If a prey population declines below a certain threshold, cougar reproduction can be adversely affected, causing population decline and potential extirpation if prey abundance does not recover (Logan and Sweanor 2001).

Population Dynamics

There has been no rigorous or systematic assessment of the BC cougar population. Notably, however, there is evidence that humans are a major cause of cougar mortality.

Survival and mortality

Causes of death for cougars are varied. Non-human causes include intraspecific conflict, disease, and injuries during capture of prey (Spreadbury 1989; Harrison 1990; Ross and Jalkotzy 1992; Ross et al. 1995; Hahn 2001; Logan and Sweanor 2001; Wilson et al. 2004). Males kill other males during conflicts over home ranges, food, and females. Moreover, males can kill kittens sired by another male, so that the mother may enter oestrus and be available to mate. While protecting their kittens from this infanticide, mothers are sometimes killed (Logan and Sweanor 2001).

Notably, humans represent a major cause of cougar mortality via hunting, lethal control, and collisions with vehicles (Spreadbury 1989; Ross and Jalkotzy 1992; Spreadbury et al. 1996; Logan and Sweanor 2001; Wilson et al. 2004; *Figure 2*; *Figure 3*). There is a relationship between the nature of human activities and cougar mortality. Transient activities can be designed to accommodate cougars, whereas permanent activities and facilities displace cougars and usually permanently foreclose options for restoration (*Table 2*).

In 1976, compulsory inspection began in BC in which all cougars killed by people must be reported to the provincial government (Hebert 1989; BC Ministry of Environment, Lands and Parks 1998; BC Ministry of Water, Land and Air Protection 2003). The body parts of the dead cougar that are required for inspection are skull, skin, male reproductive organs, and female mammary glands (BC Ministry of Environment 2009). Numbers killed by humans due to legal hunting in BC have varied from 127 to 506 per year, and average 257 per year (*Figure 3*). Numbers killed by humans due to lethal control in BC have varied from 3 to 147 per year, and average 50 per year (*Figure 3*).

Figure 2. Cougar mortality due to hunting and lethal control on Vancouver Island during 1976-2008 (BC Ministry of Environment, unpublished data).

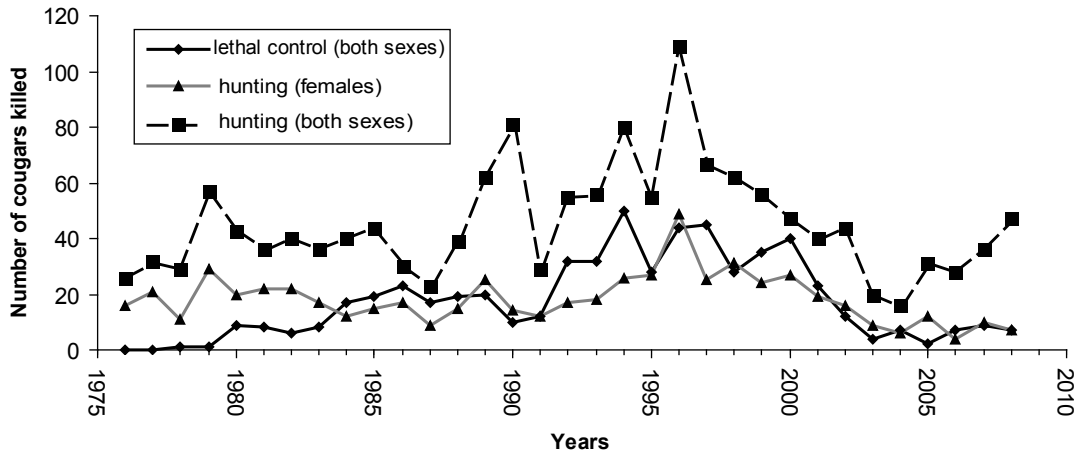


Figure 3. Cougar mortality due to hunting and lethal control in BC during 1976-2008 (BC Ministry of Environment, unpublished data).

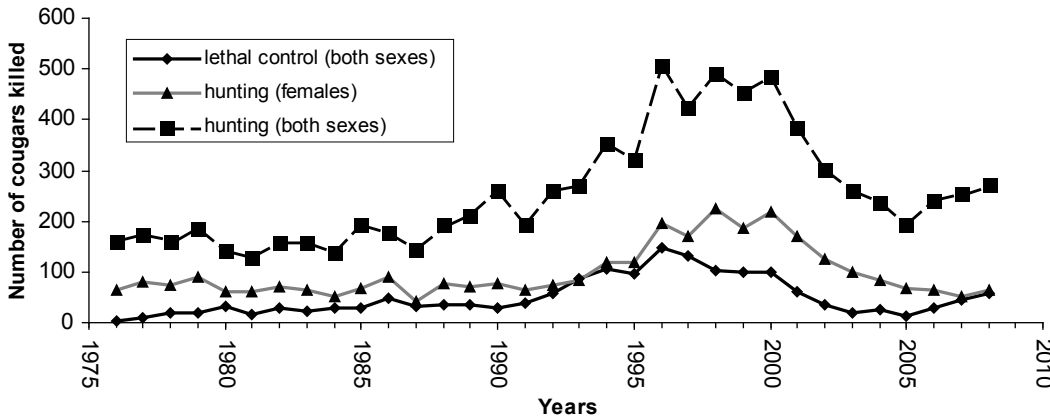


Table 2. Relationship of human activities and cougar mortality.

Nature of Activity	Cause of Mortality Direct	Cause of Mortality Indirect
Transient	Hunting, trapping, predator control, collisions with vehicles, lethal management activities	Extractive resource industries (oil, gas, logging, mining, agricultural), seasonal recreational activities
Permanent	Highways, secondary roads, railways, service corridors, dams	Recreational developments, cities, towns, infrastructure for oil, gas, electricity

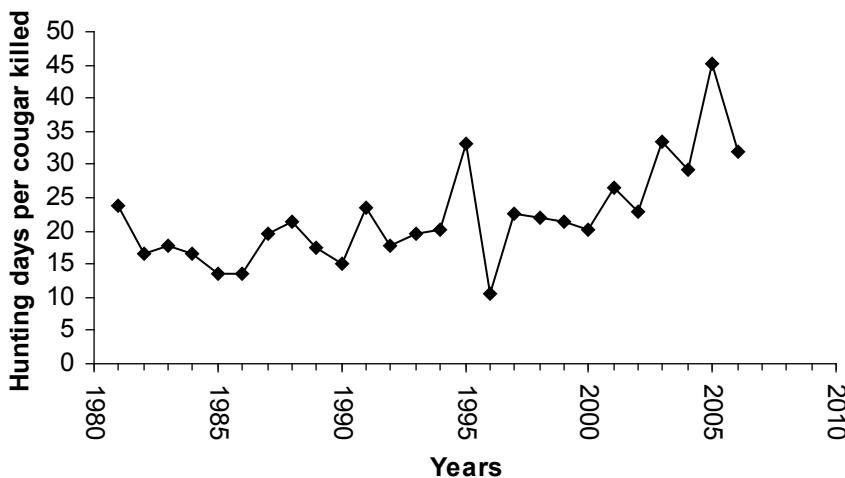
Population abundance and trends

Cougars present complex problems in estimating their numbers and trends. As they have low population densities and are cryptic, assessing population sizes and trends across large spatial scales is difficult (Logan and Sweanor 2001). Inventory methods for cougars can take many forms, some invasive and some otherwise. These include aerial and ground tracking in snow, road track counts, photo traps, and radio telemetry. Aerial tracking, however, is likely ineffective in regions with heavy forest cover (BC Ministry of Environment, Lands and Parks 1998). Across smaller spatial scales, radio telemetry is currently the best method for estimating the size of cougar populations in the province (BC Ministry of Environment, Lands and Parks 1998; Cougar Management Guidelines Working Group 2005). Non-invasive genetic sampling, including hair collection stations and backtracking in snow for hair and scat along tracks and at bedding and feeding sites, can also be used for estimating cougar populations (Logan and Sweanor 2001; Cougar Management Guidelines Working Group 2005; Sawaya et al. 2005).

Humans represent a major cause of cougar mortality via trophy hunting, lethal control, and collisions with vehicles.

Several indices can be used to monitor population size and trend. The provincial government maintains a Catch-Per-Unit-Effort (CPUE) Index (BC Ministry of Environment, unpublished data). CPUE is a gross measure of relative abundance throughout time and can ostensibly be used to assess the status of populations. Notably, trend data show that hunting days per kill across the province have increased over time, which suggests a declining population trend (*Figure 4*).

Figure 4. Catch-Per-Unit-Effort for BC during 1981-2006 (BC Ministry of Environment, unpublished data).



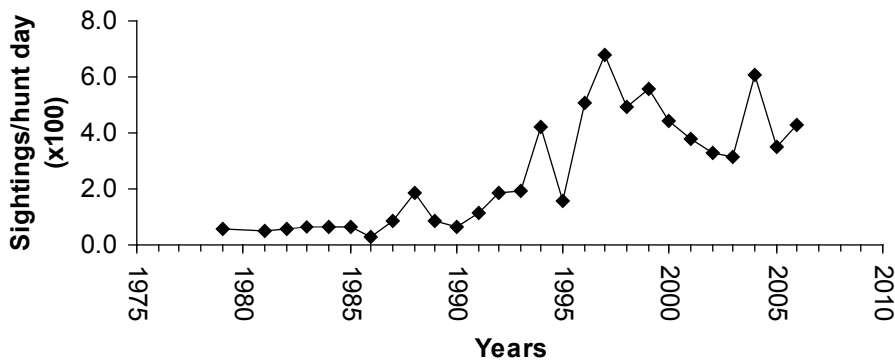
However, indices such as CPUE, track surveys, and age-sex composition of cougar killed by hunting provide only rough measures of population change. Specifically, they are thought insensitive to changes smaller than 25% in population size (Beier and Cunningham 1996; Cougar Management Guidelines Working Group 2005). Age-sex composition as a population index requires further investigation. Preferably, age-sex indices should be used over long periods and combined with other methods (Cougar Management Guidelines Working Group 2005). Based on research in Wyoming, an increase in the number of adult females killed by hunting coincided with a decrease in population size (Andersen and Lindzey 2005).

Some putative indices, however, do not effectively index population size or trend. For example, cougar sightings, predation of domestic animals, and hunting levels are not reliable (Van Dyke and Brocke 1987; Cougar Management Guidelines Working Group 2005). The number of pet and livestock predations can change due to changes in prey populations, abundance of domestic animals, and changes in husbandry practices (Cougar Management Guidelines Working Group 2005). The number of cougars killed by hunting reflects hunting effort, human accessibility, snow conditions, and technology, more so than cougar abundance, particularly if indices have not been calibrated to account for these variables (Ross and Jalkotzy 1992; BC Ministry of Environment, Lands and Parks 1998; Logan and Sweanor 2001; Dawn 2002; Cougar Management Guidelines Working Group 2005).

Another gross measure of population trend relies on information from resident hunters in BC. The provincial government maintains a Hunter Sightings Index (HSI) for Vancouver Island (BC Ministry of Environment, Lands and Parks 1998; Ministry of Environment 2009, unpublished data). Trend data show that cougar sightings have generally increased over time (*Figure 5*). A sample of resident hunters in BC is asked annually to report cougar sightings in the Vancouver Island region. Based on a sub-sample of hunters who receive and choose to return a form, an HSI of abundance is calculated. However, because hunters compete with cougars for prey, reporting might be biased, as there is incentive to over-report sightings if some hunters reason that more liberal cougar-hunting regulations will follow.

Increasing cougar-human conflict can also lead to erroneous speculation about population trends. In recent years, many people

Figure 5. Hunter Sightings Index for Vancouver Island during 1979-2006 (BC Ministry of Environment, unpublished data).



believed, based on increasing cougar-human conflict, that cougar populations in North America were at historically high densities and increasing. In fact, based on research in southeastern BC, Idaho, and Washington, cougar populations were actually at relatively low densities and declining. Accordingly, high cougar-human conflict in other BC regions might also signal population declines and burgeoning human populations expanding into cougar habitat (Lambert 2003; Lambert et al. 2006).

Notably, there has been no rigorous provincial assessment of the BC cougar population. The provincial government has estimated the BC population over time, but great caution should be exercised when considering these assessments. The estimates are ‘best guesses’ based on hunting, cougar-human conflict, and anecdotal information (Austin 2005). Provincial government confidence in the most recent estimate is low (Austin 2005). Importantly, these population estimates include adults, subadults, and kittens. Surprisingly, the provincial government estimates for the BC population have increased over time (*Table 3*), whereas scientific research has demonstrated that, for example, a population in southeastern BC has declined (Lambert et al. 2006). Many believe Vancouver Island has had one of the densest cougar populations in North America (BC Fish and Wildlife 1980). Government estimates for the Vancouver Island population have been declining (*Table 3*).

Table 3. Population estimates for BC and Vancouver Island.

year	British Columbia	Vancouver Island	Authors
1978	2660		Hebert (1989)
1979	3300 ± 20%	1200	BC Fish and Wildlife (1980)
1980	3300		Hebert (1989)
1986		450-700	BC Ministry of Environment, unpublished data
1988	2800		Hebert (1989)
1988	3000-3500		Hebert and Lay (1997)
1995		700-800	BC Ministry of Environment, unpublished data
1997	> 4000		Atkinson (1997)
2001		300-400	BC Ministry of Environment, unpublished data
2005	4000-6000		Austin (2005)

Conservation Planning

Cougar conservation requires the protection of connected habitat such that individuals can disperse among populations. However, human-caused habitat fragmentation is a major impediment to cougar conservation. Notably, no protected areas for cougars have been created in BC. Cougar conservation would benefit from the protection of a mosaic of habitats at all scales. Unmistakably, there is a need for science-based, ecosystem-level conservation planning such that biodiversity is safeguarded in the province. Cougars could be used as a focal species for such planning in BC.

Habitat fragmentation

Many ecologists have suggested that human-caused habitat fragmentation is a major impediment to cougar conservation (Logan and Sweanor 2001). Importantly, the preliminary management plan for cougars predicted that the provincial population would likely decline over time owing to habitat loss and prey population decline (BC Fish and Wildlife 1980). As with other large carnivores, cougars have low population densities, large home ranges, and long dispersal distances, and are thus vulnerable to habitat fragmentation (Chetkiewicz and Boyce 2002; Crooks 2002; Sunquist and Sunquist 2001; Cougar Management Guidelines Working Group 2005). Human development, including roads and other infrastructure, increases habitat fragmentation (Sweanor et al. 2000; Sunquist and Sunquist 2001; Cougar Management Guidelines Working Group 2005). Roads can have negative ecological effects such as changes in home ranges and movement; population fragmentation; mortality from collisions with vehicles; and increased use of areas by humans, including hunting (Trombulak and Frissell 2000).

Habitat fragmentation affects cougars in many ways. For example, habitat fragmentation can reduce cougar dispersal and genetic diversity, and increase the risk of population extirpation (Logan

Cougar conservation requires protection of extensive areas of connected habitat.

and Sweanor 2001; Loxterman 2001; Ernest et al. 2003; Cougar Management Guidelines Working Group 2005). In Idaho, research has shown reduced genetic diversity and increased inbreeding within cougar populations occupying more human-caused fragmented habitat, as compared with populations occupying less fragmented habitat (Loxterman 2001). In California, the likelihood of cougar occurrence declined as habitat patches became smaller and more isolated (Crooks 2002).

Degradation of habitat resulting from residential developments, recreational developments, and road building for access to residential, recreational, and industrial activities is likely the most serious threat to cougars in western Canada. Moreover, intrusion into cougar habitat increases potential for conflict along the urban-wildland interface. In Arizona and Utah, cougars demonstrated a negative response to increasing human activity (Van Dyke et al. 1986).

Cougar habitat can also be naturally fragmented. For example, in contrast to many other cougar populations, BC is home to coastal cougars that swim in the ocean among landmasses. Due to these water barriers, there is likely little genetic exchange between the islands and the mainland (Hahn 2001). Such barriers to movement have left their mark on the population structure on the coast; evidence of inbreeding and reduced genetic variation has been documented in Vancouver Island's cougar population (Culver et al. 2000; Shaw et al. 2007). In general, island populations are more vulnerable than mainland populations to disturbance and extirpation as they often have less genetic variation.

Logging effects on cougar and prey habitat in temperate rainforests

Many research and management questions have focused on whether industrial forestry adversely influences cougars and their prey. Because cougars and their prey evolved without logging, we can reasonably expect that most effects will be negative in the long term. To date, however, research has provided somewhat equivocal answers, suggesting alteration of habitat via logging can affect cougars and prey in unpredictable ways in the short and long term. On Vancouver Island, the rate of cougar predation on their ungulate prey might be increased due to logging practices in which ungulate winter ranges are

fragmented and roads facilitate cougar movement (McNay and Voller 1995). On northeastern Vancouver Island, clearcuts were avoided by cougars (Goh 1999). In contrast, in southeastern BC, cougars used clearcuts, neither avoiding nor selecting for them (Spreadbury 1989).

One of the most important implications of logging is its effects on prey. At least in coastal temperate rainforests, clearcut logging is thought to reduce the long-term carrying capacity for deer (Alaback 1982), which are the primary prey for coastal cougars (*below*). Reduced browse quantity and quality reduce the carrying capacity for deer, which in turn decreases predator abundance (Person 2000).

Succession of vegetation following clearcutting in temperate rainforests follows a chronology with known effects on forage quantity and quality. A temporary increase in forage production may follow clearcutting in some areas (Happe et al. 1990). Moreover, female deer have been shown to select clearcuts during mild winters in Alaska (Yeo and Peek 1992). However, a more comprehensive perspective is required to evaluate the long-term influence of industrial forestry on deer populations. Early successional browse in clearcuts may be abundant but can be of poorer nutritional quality than in old-growth stands (Van Horne et al. 1988; Hanley et al. 1989; Happe et al. 1990). Moreover, the depth of logging slash affects accessibility to and use of clearcuts by deer (Lyon and Jensen 1980).

More notably, available evidence suggests that clearcutting eventually changes productive old-growth forests into even-aged, second-growth stands of much lower habitat value for deer. Starting in the mid-successional or “stem-exclusion stage” (15-35 years), the dense canopy severely limits forage. These conditions may persist for 150 to 200 years if no additional harvesting occurs. However, under short-rotation, even-aged management, some understory plant species may never regenerate (Wallmo and Schoen 1980; Alaback 1982; Schoen et al. 1988). This loss in structure and function can be considered permanent.

The ultimate factors of decreased habitat quantity and quality are responsible for reducing the long-term carrying capacity for deer. The proximate causes in declines are increased intraspecific competition for food and shelter that lead to decreased reproduction and increased chronic mortality (Caughley and Sinclair 1994; Person et al. 1996).

In areas or years with heavy snowfall, the influence may be particularly severe. Forage in clearcuts may be unavailable or may require significant energy to access (Schoen and Kirchhoff 1985; Harestad et al. 1982). During periods of deep snow in Alaska, high volume old-growth stands received disproportionately high use by deer, likely because this forest type is most effective at intercepting snowfall (Kirchhoff and Schoen 1987; Schoen and Kirchhoff 1990). In Alaska, deer concentrated their activities in the highest volume old growth within their home ranges when snow depth reached as little as 15 cm (Schoen and Kirchhoff 1990).

Protected areas

All else being equal, basic principles of conservation biology dictate that many populations with many individuals are better than few populations with few individuals, extensive and connected natural areas are better than small and isolated areas, and maintenance of heterogeneity in space and time is better than homogenization of landscapes or genes.

As implied above, cougar conservation requires protection of extensive areas of connected habitat with genetically linked subpopulations so that individuals can disperse among subpopulations and migrate between seasonal ranges. These large areas for cougars and their prey should be thousands of square kilometres (Logan and Sweanor 2001; Pierce and Bleich 2003; Cougar Management Guidelines Working Group 2005). Importantly, small, unconnected cougar populations are at increased risk of extirpation (Sweanor et al. 2000; Logan and Sweanor 2001).

Even with adequate information, rigorously identifying and protecting critical seasonal habitat for different age and sex classes in all of BC's regions might be impossible. Consequently, protecting a variety of environments at all scales is important. Moreover, allowing cougars to access habitats with ecological heterogeneity at the landscape scale supports ecological, genetic, and phenotypic diversity within populations. This is important for maintaining the evolutionary potential of populations (Crandall et al. 2000).

Although forming one of the provincial government's key recommendations more than 20 years ago, no protected areas have been established for cougars (BC Fish and Wildlife 1980; Hebert 1989). If British Columbians favour viable and healthy ecosystems, which

There is a need for science-based, ecosystem-level conservation planning such that biodiversity is safeguarded in BC.

include robust populations of cougars and prey, then a province-wide protected areas strategy is needed. At present, many of the existing protected areas in the province are small, unconnected, and not high-value cougar habitat. As many of these areas have been designated primarily for aesthetics and recreation, as opposed to biodiversity, conservation biologists have recommended that BC develop a comprehensive strategy that protects habitats and maintains viable populations of native species (Moola et al. 2007). Unmistakably, there is a need for science-based, ecosystem-level conservation planning such that biodiversity is safeguarded in BC. Below we outline key steps necessary to realize this vision.

Because ecological processes and species movements often span parks and protected area boundaries, evaluating current reserve networks in relation to surrounding unprotected habitat is necessary. The connectivity of habitat areas increases the effective size of existing protected areas and plays a critical role in species persistence, thus it has long been known that loss of connectivity can lead to localized extinctions. Connectivity of core habitat areas (i.e., those locations that are well buffered from the influence of human disturbance such as roads and associated development) is also important for biotic health and species responses to climate change, with dispersal pathways between suitable habitat areas necessary to ensure species viability over ecological time.

Focal species for conservation planning

Large carnivores, including cougars, can be used as focal species for this ecosystem-level conservation planning. Due to their large home ranges and long dispersal distances, large carnivores are useful for determining which habitats to protect and how best to connect these areas (Noss et al. 1996; Carroll et al. 2001). Protecting large carnivore habitat, including that which provides for cougars, protects habitat for other species, ecological processes, and biodiversity (Miller et al. 1999; Carroll et al. 2002; Cougar Management Guidelines Working Group 2005). A conservation areas design was created specifically for the inland temperate rainforest in BC, which used cougars as a focal species (Craighead 2004). Accordingly, conservation-planning processes conducted by the government and other parties should consider this document.

Notably, however, large carnivores do not provide a complete umbrella for biodiversity. Not all life forms and processes will be protected by focusing only on the conservation of large carnivores. Consequently, it is important to use other conservation-planning methods as well (Carroll et al. 2002; Ray et al. 2005).

Ecological and Evolutionary Implications of Trophy Hunting

Hunting regulations in BC do little to avoid overexploitation of cougar populations. BC cougars are hunted for trophies with incomplete knowledge of population size and little control over the number and distribution of cougars that are killed. Although illegal to kill a mother when she is in the company of her kittens, killing a mother while she has left her kittens in the safety of a nursery or rendezvous site is legal.

We know far less about hunting cougars than many advocates for hunting claim. Supporters of cougar hunting, including those responsible for managing cougar hunts, are prone to overestimate the resiliency of cougar populations and overestimate the maximum sustainable harvest rates. Although some believe we have the technical aptitude to manage cougar hunts, there is good reason to doubt that we have the ability to manage a *sustainable* cougar harvest in BC.

There is overwhelming logical, cultural, and sociological evidence that: i) decisions about hunting should be made from the perspective of not hunting a population unless there are adequate reasons to do so; ii) having the technical ability to manage a hunt is not, by itself, an appropriate reason to hunt any population; iii) reasons for hunting cougars have not been properly evaluated; and iv) the adequacy of a reason to hunt should be judged in relation to the principle that killing a sentient being matters.

What is a ‘sustainable’ cougar hunt?

Before assessing reasons for and against hunting cougars it should be recognized that the primary goal of any recreational or ‘sport’ hunt should be that it is ‘sustainable’. Indeed, the BC provincial agencies recognize the appropriateness of this value. However, there are reasons to think that decision-makers are working with outdated notions of sustainability. Whereas there is much debate about the exact na-

ture of sustainability and sustainable management, there is virtually zero debate that it requires ‘meeting human needs in a socially-just manner without disenfranchising the health of native populations or ecosystems.’⁴ Only minimal reflection is required to know, for example, that sustainability does not simply mean being able to exploit as much as desired without infringing on future ability to exploit as much as desired.

4 For example, see J. B. Callicott, K. Mumford. *Cons. Bio.* 11, 32 (1997); National Research Council, “Our common journey: a transition toward sustainability” (National Academy Press, Washington, DC, 1999); World Commission on Environment and Development (1987): *Our Common Future*. Oxford University Press, Oxford, New York – this document is commonly referred to as *The Brundtland Report*; IUCN, UNEP, WWF (1991): *Caring for the Earth. A Strategy for Sustainable Living*. Gland, Switzerland.

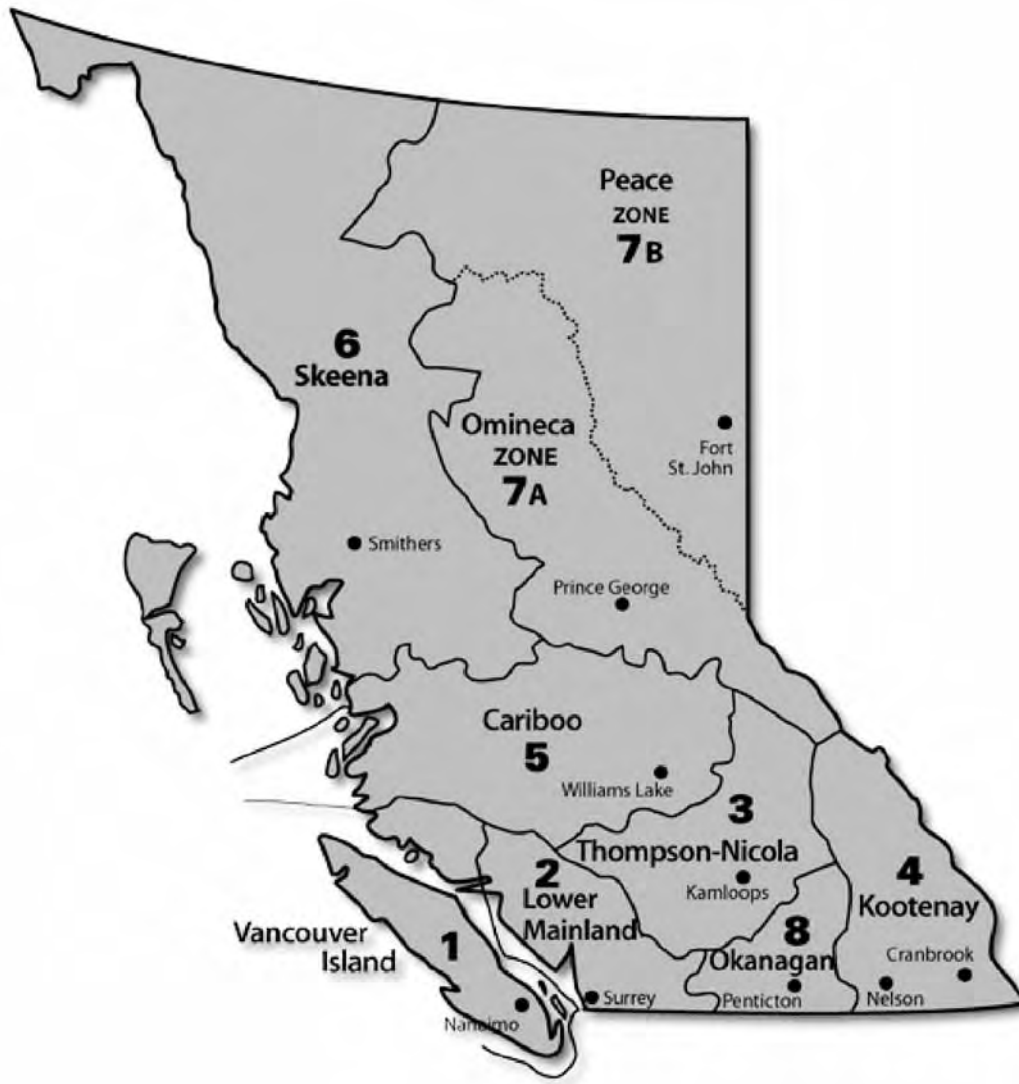
Policymakers often seem to overlook two critical aspects of sustainability. First, contemporary notions of sustainability include notions of population health *and* ecosystem health. To manage cougars for viability and self-sustenance, but not for contributions to ecosystem health (where ecosystems include people), represents unsustainable management of cougars. This principle is in no way radical or foreign to BC provincial agencies. Since the mid-1990s, almost every federal, provincial, and state agency has expressed commitment to ecosystem management.

Second, because the concept of sustainability is general in scope, a more precise meaning of sustainability for cougar hunting must be specified and evaluated. This principle of sustainability is perfectly analogous to a traditional and fundamental principle of natural resource management. That is, *appropriate natural resource management is based on actions that are likely to achieve goals that have been shown to be desirable*. Judging the appropriateness of a cougar hunt – that is, judging whether a cougar hunt is sustainable – would require assessing: whether the goals of the hunt are sustainable, and whether the hunt is likely to achieve that goal. To repeat, by ‘sustainable goal’, we mean a management goal that meets human needs, is socially just, and does not disenfranchise the health of populations or ecosystems.

Management of trophy hunting

Cougar-hunting regulations vary among BC regions and management units. For hunting purposes, the province is divided into 8 regions, and each region comprises many management units (e.g., the Vancouver Island region has 15 management units) (BC Ministry of Environment 2009; *Figure 6*). Small changes have been made over time to provincial hunting regulations (e.g., bag limits, quotas, season lengths, pursuit-only hunting). Beginning in 1966, season lengths and bag limits were gradually introduced in the province (BC Fish

Figure 6. BC regions (BC Ministry of Environment).



and Wildlife 1980). To hunt cougars legally, an individual is required to purchase a cougar species license (\$30 for a resident and \$230 for a non-resident of BC), in addition to the cost of a 1-year basic hunting fee. Cougar ‘bag limits’ (i.e., the number of cougars that an individual can legally kill) vary from 1 to 2 among regions and management units. Cougar-hunting seasons generally occur during fall, winter, and spring months. Currently, in the Vancouver Island region, cougars are only free from exploitation and harassment from hunting for 3 months during the year. Hunting is not legal in national parks, although it is legal in many provincially protected areas. Notably, trapping cougars in BC is not legal (BC Ministry of Environment

Although illegal to kill a mother when she is in the company of her kittens, killing a mother while she has left her kittens in the safety of a nursery or rendezvous site is legal.

2009). However, some cougars are unintentionally trapped and some are killed illegally (BC Ministry of Environment, unpublished data).

In BC, cougar hunting is managed as a general open system, which limits the number of cougars an individual hunter can legally kill. The total number of hunters, however, is unrestricted (Austin 2005). The length and timing of the season and the number of cougars an individual hunter can legally kill are regulated. Ultimately, however, there is no provincial control over how many cougars are killed or where they are killed in each year. Notably, cougar populations can be overexploited during years with high snow accumulations or frequent snowfalls, when tracking conditions are better (Dawn 2002; Laundre and Clark 2003; Cougar Management Guidelines Working Group 2005).

Many biologists and managers recommend quota and limited entry systems rather than the open system used in BC. Limited entry systems control the number of individual hunters. However, the number of cougars killed can be varied over time depending on snow abundance and other variables (Dawn 2002; Cougar Management Guidelines Working Group 2005). Similarly, quota systems can control the distribution, number, and sex of cougars that are killed, by making it illegal to continue killing cougars in specific management units once the legal quota has been reached (Dawn 2002; Laundre and Clark 2003; Cougar Management Guidelines Working Group 2005). In addition, some biologists recommend managing cougar-hunting using metapopulation and source-sink frameworks (Logan and Sweanor 2001; Laundre and Clark 2003; Cougar Management Guidelines Working Group 2005). Others recommend the use of cougar management zones that have different objectives such as lethal control, hunting, and maintenance of cougar sanctuaries (Logan and Sweanor 2001; Cougar Management Guidelines Working Group 2005).

Ecological consequences

In addition to reducing numbers, hunting influences cougar populations in complex and often unpredictable ways. In Utah, for example, a heavily-hunted population had a younger age structure, less social stability, lower survival, lower reproduction, and a declining population density, as compared with a lightly-hunted population (Stoner et al. 2006).

Approximately 75% of adult female cougars are raising kittens each year.

Commonly across cougar range, hunting management can adversely affect the persistence of cougar populations. This is because cougar conservation depends in part on preventing overexploitation resulting from excessive human-induced mortality (Logan and Sweanor 2001). Throughout North America, however, management strategies have done little to prevent overexploitation and appear to be ‘testing the limits’ of cougar populations to withstand exploitation (Dawn 2002). Cougar management is often based on the dubious premise that killing rates can be maintained at a constant level as long as populations continue to sustain hunting. Some biologists argue that management in most of North America follows a ‘sledgehammer’ approach in which hunting regulations allow the number of cougars killed to be increased to the point that population indices derived from hunting data indicate that the population has been ‘hammered’ into a decline (Logan and Sweanor 2001). At present, this appears to be the approach used for cougars in BC. Specifically, cougars are hunted with little control over the number and distribution of the animals that are killed. Clearly, this puts cougar populations in serious jeopardy, particularly when determined without a rigorous and systematic estimate of cougar abundance.

Hunting small and isolated cougar populations can lead to extirpation. Hunting can also create population sinks and reduce dispersal from sources to sinks. Overexploitation of one cougar population can negatively affect the regional population due to a reduction in the number of dispersing subadults (Spreadbury et al. 1996; Logan and Sweanor 2001; Cougar Management Guidelines Working Group 2005).

In BC, hunting regulations do very little to protect females. Indeed, BC government biologists have specifically expressed concern regarding the number of female cougars killed due to hunting (Hebert 1989). This critical management issue needs to be addressed because killing females negatively affects population persistence by reducing overall rates of reproduction (Loxterman 2001; Dawn 2002). In addition, female cougars often remain in areas in which they were born. Consequently, they are not easily replaced by dispersing subadults from other populations, which exacerbates the problem (Loxterman 2001). Finally, the social behaviour of individual cougars as well as ecologically important community relationships can be altered by the premature mortality of adult females. For example, killing

We suspect that most British Columbians – cougar hunters included – would agree with our view that it is morally indefensible to cause the orphaning, starvation, and death of cougar kittens for the trophy and thrill provided by killing their mothers.

adult females disrupts established matrilineal structures (Logan and Sweanor 2001). As with wolves (Haber 1996), hunting of cougars might also hinder the transfer of culturally acquired information that is important for population persistence. Accordingly, some biologists have argued for the protection of female cougars from hunting (Logan and Sweanor 2001). Based on research in southeastern BC, Idaho, and Washington, in which hunting caused 92% of cougar mortality, Lambert and colleagues (2006) recommended a reduction in cougar hunting, especially for females.

Hunting regulations in BC also do little to avoid orphaning of kittens. As cougars give birth throughout the year, cougar hunting cannot be scheduled to avoid the orphaning, starvation, and death of cougar kittens (Ross et al. 1996; Logan and Sweanor 2001). Although illegal to kill a mother when she is in the company of her kittens, killing a mother while she has left her kittens in the safety of a nursery or rendezvous site is legal. Mothers often leave their kittens in the safety of such sites, while they search for food for themselves and their family. Determining by direct observation if a female has kittens is difficult, even in the best circumstances (Barnhurst and Lindzey 1989; Spreadbury 1989; Ross and Jalkotzy 1992; Spreadbury et al. 1996; Dawn 2002; Cougar Management Guidelines Working Group 2005). In Utah, for example, the tracks of kittens were found alongside their mothers' tracks only 25% of the time (Barnhurst and Lindzey 1989). Further, distended mammary glands, which are evidence that females are caring for kittens, are not always visible, even when a female has kittens (Logan and Sweanor 2001).

Mortality of mothers due to hunting adversely affects individual kittens and cougar conservation. Importantly, kittens are completely dependent on their mothers for food and safety. Cougar mothers dedicate much time and energy feeding, grooming, teaching, protecting, and otherwise actively caring for their kittens (Logan and Sweanor 2001). Significantly, scientific research has consistently demonstrated that approximately 75% of adult female cougars are raising kittens each year (Spreadbury et al. 1996; Logan and Sweanor 2001; Lambert et al. 2006). Further, many females pursued and killed by hunters are pregnant. Consequently, killing a female likely means killing on average more than one individual in a population.

Orphaned kittens often do not survive. They can starve while awaiting their mothers' return at nursery and rendezvous sites (Logan

and Sweanor 2001; Dawn 2002; Cougar Management Guidelines Working Group 2005). Kittens orphaned when less than 9 months old will likely die and kittens older than 9 months will be less likely to survive than if they were still in their mothers' care (Logan and Sweanor 2001). In southeastern BC, Idaho, and Washington, for example, 5 of 21 cougar kittens in the study area died because their mothers were killed by hunting (Lambert et al. 2006).

Although some cougars are killed opportunistically by hunters seeking other species such as deer, most are killed with the use of hounds that trail, chase, and tree cougars. Recognizing that some people disagree with the ethics of using hounds to hunt cougars, hunting with hounds can provide an opportunity to determine sex and potentially reduce the number of females killed (Cougar Management Guidelines Working Group 2005). Hounds are commonly used by researchers who extol the advantages of capturing and straightforward sexing of study animals (M. Jalkotzy personal communication). For example, while conducting field research in BC, Spreadbury (1989) was able to identify reliably the sex of treed adult cougars. Specifically, adult males can be distinguished from adult females by their external reproductive organs, via the presence of a conspicuous spot of black hair (Spreadbury 1989; Logan and Sweanor 2001). Hunters, who lack biological training, however, might not be able to reliably sex treed cougars. But if regulations do not prohibit the killing of females, an ability to discriminate might not make a difference in the sex ratios of killed animals.

To resolve this issue, some biologists have recommended low quotas for males and very low quotas for females. The specific idea is to protect females while making lawful the accidental killing of females mistakenly identified as males. Thus, mortalities of females that typically go unreported by hunters because of fear of prosecution will be recorded (Logan and Sweanor 2001). Notably, some management units in BC currently have female quotas (BC Ministry of Environment 2009). Suggesting that cougar populations are vulnerable to the overexploitation of females, the 2006-07 BC hunting regulations introduced a temporary initiative in which hunters were encouraged to kill male rather than female cougars (BC Ministry of Environment 2006). Similarly, hunters in the Okanagan region have been encouraged recently to kill males rather than females, with the suggestion that overexploitation of females might result in an end

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We believe that it is morally indefensible to harass cougars via pursuit-only hunting.

to cougar hunting for the year (BC Ministry of Environment 2009). In our view, however, encouragement and voluntary compliance as opposed to clear regulation will not effectively reduce the killing of females. If voluntary measures fail, we recommend male-only quotas and substantial penalties for killing females. These quotas should be tied to current empirical estimates of cougar abundance.

Current regulations in BC are somewhat ambiguous as to the legality of killing kittens. This is because the immature pelage of kittens changes gradually and is not unmistakably diagnostic for age. Kittens are born with black spots and black rings on their tails. These spots fade over time and disappear by approximately 24 months (Logan and Sweanor 2001; Pierce and Bleich 2003). The definition of kitten for cougar hunting in BC is a cougar that is spotted and/or less than 1-year-old (BC Ministry of Environment 2009). The protection of mothers and their kittens, when observed in a family group, began in 1980 (Hebert 1989). However, killing a kitten while not in the presence of a mother was legal until the 2004-05 hunting season (BC Ministry of Water, Land and Air Protection 2004).

Cougars can be harassed in non-lethal ways. During the regular hunting season and ‘pursuit-only’ season, these sensitive cats are chased with hounds into trees for viewing and hound practice. Some management units in BC have pursuit-only seasons in which killing a cougar is not allowed, although cougars can legally be chased and treed (BC Ministry of Environment 2009). During pursuit-only seasons, adults and kittens are sometimes attacked by hounds (Roberson 1984), or chased to exhaustion.

The impact of allowing such harassment can be extensive. In Utah, for example, an individual cougar was repeatedly chased over several consecutive days and several times a day (Roberson 1984). Likewise, over 3 months in southeastern BC, 5 males were treed 8 times and 4 females were treed 9 times as part of the cougar-hunting season (Spreadbury 1989). Importantly, stress and trauma caused by repeated pursuit of individuals might compromise cougar physiology (Roberson 1984; Harlow et al. 1992). Notably, in Alberta, due to ecological concerns, there is now a moratorium on pursuit-only hunting (Alberta Fish and Wildlife 1992).

Hunting can also have less obvious effects on cougar mortality. For example, hunting can cause cougar mortality via injuries related

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to pursuit by hounds and the killing of adults and kittens by hounds (Dawn 2002). Further, kitten mortality due to infanticide might be increased owing to disruption of social mechanisms that ensure the exclusive use of home ranges by adult males. This is because the killing of resident territorial males allows immigration of new males that often kill unrelated kittens (Ross and Jalkotzy 1992; Logan and Sweanor 2001; Dawn 2002). In Washington, in comparison to a lightly-hunted population of cougars, a heavily-hunted population had increased immigration from potentially infanticidal males and reduced kitten survival (Cooley et al. 2009). Likewise, in a population of grizzly bears, research has demonstrated that when immigrating males and resultant infanticide is taken into account, killing one adult male has the same effect as killing 0.5 to 1.0 adult females, in terms of declines in population productivity (Swenson et al. 1997).

Increased access for humans via roads, cutlines, and trails throughout cougar distribution can also increase cougar mortality. Ever-accumulating kilometres of logging roads increase access for hunting (Dewar and Dewar 1976). The increase in snowmobile use and associated increased access for hunting is increasing pressure on BC populations (BC Fish and Wildlife 1994).

Evolutionary consequences

Although little is currently known, hunting likely also has evolutionary consequences for cougars. Importantly, cougars evolved without hunting. Moreover, human-induced selection via hunting usually differs from natural selection (Darimont et al. 2009). In contrast to natural predators, which typically take the ‘newly born or the nearly dead’, hunters generally kill large males and large females that are the most reproductively successful (Logan and Sweanor 2001). Consequently, many biologists have recommended that natural selection be allowed to continue unhindered in many areas. Areas managed for reduced hunting might provide refugia in which such natural selection could occur (Logan and Sweanor 2001; Cougar Management Guidelines Working Group 2005). From an evolutionary perspective, because hunting mortality and mortality from natural processes do not typically remove the same individuals, we would expect that hunting might affect evolutionary trajectories of populations. To avoid any potential implications, a precautionary approach would eliminate the killing of cougars by humans.

Cougar sanctuaries

Before the last couple of centuries, all cougar habitat was a safe haven from hunting. Many biologists have recommended the creation of cougar sanctuaries where cougars are not subject to hunting (Cougar Management Guidelines Working Group 2005; Shaw et al. 2007). Notably, there are currently some refuge zones in BC in which hunting is illegal (e.g., Strathcona Provincial Park on Vancouver Island). These areas, however, comprise only a tiny fraction of the province.

Lethal Control

BC cougars have been persecuted via lethal control during bounty programs and in relation to endangered species.

In addition to exploitation from hunting, BC cougars have been persecuted via lethal control during formal bounty programs. In the recent past, killing of cougars was supported by the BC government during a bounty that put ‘severe and unwarranted’ pressure on cougar populations (BC Fish and Wildlife 1994). From 1910 until 1957, this program was responsible for the death of more than 20,000 cougars in BC (Hebert 1989).

Lethal control can target specific individuals or entire populations. In BC, it is generally conducted by shooting, as opposed to trapping, poisoning, aerial gunning, and reproductive sterilization. BC Conservation Officers often respond to all types of cougar-human conflicts by killing individual cougars (Austin 2005).

Lethal control of individual cougars is not necessarily an effective strategy for reducing cougar-human conflicts, although selective killing of individual cougars might benefit human safety in some circumstances. Specifically, a cougar involved in injuring or killing a human might be prone to engage in dangerous conflicts with other humans (Beier 1992). However, lethal control of individual cougars related to predation of either domestic animals or endangered prey has been shown to be ineffective over the long term. This is because killing a cougar can vacate a home range that will likely be filled by a nearby or dispersing individual.

Lethal control of cougar populations – as opposed to individual cougars – is also ineffective over the long term for reducing risks to human safety as well as predation of domestic animals and endangered prey. There is no credible scientific evidence that hunting cougars over a relatively short period reduces the likelihood of predation of domestic animals (Cougar Management Guidelines Working

Group 2005). Significantly, there is diversity in what individual cougars eat. Thus, lethal control efforts that target cougars to safeguard domestic animals and endangered prey might mistakenly kill individuals that never consume them.

We do not advocate lethal control of cougars. However, if lethal control is deemed necessary to protect endangered prey, the following options should be considered. First, deciding beforehand how to determine scientifically when the management goals have been reached is important. Strategies that include lethal control should address all factors affecting prey populations, including habitat loss. Likewise, it is important to consider its effects on both the regional cougar population and biodiversity conservation. Lethal control might only be ecologically effective when there is scientific evidence that: i) cougar predation is the strongest limiting factor affecting the prey population; ii) cougar predation is additive to other causes of mortality; iii) regulation is top-down; iv) prey are in excellent condition; and v) the prey is the primary species consumed by cougars (Logan and Sweanor 2001; Bowyer et al. 2005; Cougar Management Guidelines Working Group 2005; Sinclair and Byrom 2006).

Cougars have been implicated in conservation concerns over Vancouver Island marmots. Predation might be one of several proximate causes contributing to their decline (Bryant and Page 2005). However, as Vancouver Island marmots now exist at very low abundance, the impact of predation is thought to be the result of inverse density-dependent predation by opportunistic predators that are dependent on other prey species. In other words, as marmots became scarce, their population became even more vulnerable to cougar predation. Importantly, lethal control of predators such as cougars would not address the ultimate, higher-order processes of human-caused habitat loss and climate change that have affected marmots (Sinclair and Byrom 2006).

Similarly, as a component of recovery plans for endangered mountain caribou, BC cougars are currently lethally controlled. This is implemented via hunting to reduce local cougar populations. Individuals cougars that, in theory, specialize on mountain caribou might also be targeted. Meanwhile, the protection of critical habitat for caribou forms only a small part of the recovery plans (Wilson 2009). The provincial government recovery plan for caribou relies on lethal control and yet not all remaining mountain caribou habitat

Lethal control related to recovery plans for endangered mountain caribou will likely be ineffective for conserving caribou and yet potentially harm cougar populations and the entire ecosystem.

is protected, particularly habitat that caribou share with cougars (Wilson 2009). However, some biologists note that it might be too late to reduce the effects of industrial logging and other habitat destruction to conserve mountain caribou (Wittmer 2004).

Issues involving mountain caribou in southeastern BC are very complex and there are many uncertainties. Predators and prey in this inland temperate rainforest have coevolved over millennia. Although further investigation is required, a major proximate cause of caribou decline might be predation by several species, including cougars (Wittmer 2004; Wittmer et al. 2005). Although few data exist regarding predator and prey abundances within mountain caribou distribution, logging might have caused increases in other prey populations, which supported increased predators and thus increased predation on caribou (Kinley and Apps 2001; Wittmer 2004; Wittmer et al. 2005). There is no rigorous scientific evidence that cougars have increased within mountain caribou distribution and, indeed, it now appears that cougar abundance is low in the region (Lambert et al. 2006). Notably, cougars are not a major cause of caribou mortality, having contributed to only 14 of 165 caribou mortalities (Wittmer et al. 2005).

Cougar predation on caribou is likely opportunistic as they search for primary prey. In southeastern BC, Washington and Idaho, only 8.2% of 2,189 cougar relocations overlapped with mountain caribou distribution. In addition, 9 of 16 cougar home ranges did not at all overlap with mountain caribou distribution (Katnik 2002). Thus, if lethal control proceeds, selective targeted killing of specific individual cougars (i.e., that kill caribou or whose home range includes caribou) rather than indiscriminate, large-scale reduction of the cougar population would be the most effective for decreasing the likelihood of cougar predation of caribou (Katnik 2002). This might be effective, however, only in the short term, until other cougars fill the vacant ranges of the individuals killed. Thus, cougars would likely be lethally controlled over an indefinite period.

In our view, lethal control related to recovery plans for endangered mountain caribou will likely be ineffective for conserving caribou and yet potentially harm cougar populations and the entire ecosystem. Further, we predict that ongoing logging of mountain caribou habitat may continue to increase cougar predation of caribou. Significantly, the effects of lethal control on carnivore conservation

We recommend that the provincial government address prey habitat issues throughout BC well in advance, before relying on lethal control as a final attempt to rescue endangered prey from extirpation.

are not adequately considered in recovery planning for mountain caribou.

In general, lethal control in the context of protecting endangered prey is often initiated in lieu of protecting their habitat. We recommend that the provincial government address prey habitat issues throughout BC well in advance, before relying on lethal control as a final attempt to rescue endangered prey from extirpation. Non-lethal alternatives are available, including the protection of habitat for cougars and their prey. Moreover, protecting predator and prey habitat in advance, rather than falling back on lethal control to manipulate artificially species abundances, reflects an understanding that ecosystem persistence is not dependent upon human interference.

Cougar-human Conflict and Coexistence

BC – and Vancouver Island in particular – is an international hotspot for cougar-human encounters and other conflicts. The most effective long-term strategies for reducing these cougar-human conflicts are non-lethal and emphasize education.

Cougar conservation requires the reduction or elimination of cougar-human conflicts. As 10,000 years of history suggest, coexistence between cougars and people is possible in the province. This, however, requires modification of human behaviour and a level of tolerance by people. A small risk of cougar-human conflict (e.g., negative encounters with humans and cougar predation of domestic animals) will always exist. Human and cougar distributions often overlap, which also means that sometimes cougars and humans will compete over prey; cougars will occasionally prey on pets and livestock; cougars might prey on endangered species; and most unsettling, cougars will likely continue to cause human injury and death (Logan and Sweanor 2001; Katnik 2002; Pierce and Bleich 2003; Cougar Management Guidelines Working Group 2005).

Cougar encounters can be either positive or negative. Some are thrilled to have had the opportunity to observe such an elusive and beautiful animal. Cougars generally avoid encounters with humans. They are most active at dawn, dusk, and throughout the night (Logan and Sweanor 2001). However, many people fear cougars. This is because there is always a small risk that defensive and predatory behaviours of cougars will be directed toward humans. Notably, the chance of encountering a cougar is low for most British Columbians. Further, *negative* cougar-human encounters are very rare, especially when considered in the context that cougars and humans are often near one another – even if humans are unaware of this fact (Beier 1991, 1992). Moreover, human *deaths* due to negative encounters with cougars are particularly rare (Cougar Management Guidelines Working Group 2005). To place the risk into context, a British Columbian is much

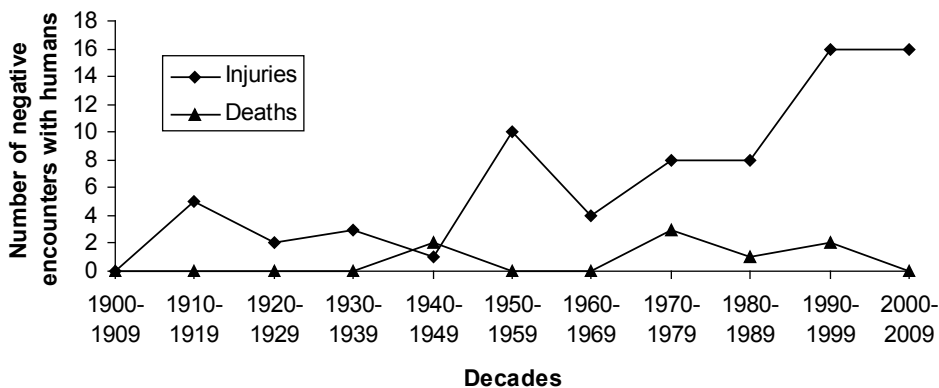
more likely to be killed by a domestic dog, stinging insect, an ungulate, or another human than by a cougar.

Based on an analysis of 262 behavioural responses of cougars to encounters with researchers in New Mexico, cougars showed threat behaviour during only 6% of observations (Sweaner et al. 2003). Biologists reported that when cougars were unintentionally encountered within 5-10 m, the cats quietly left the area or froze in position moving only their eyes, ears, or head. Some slowly shifted their body so they could more easily observe the researchers or quickly leave the area. Others fell asleep (Logan and Sweaner 2001).

BC – and Vancouver Island especially – is an international hotspot for cougar encounters resulting in human injury or death. In Canada and the United States, 20 of 53 such encounters that occurred from 1890 through 1990 were on Vancouver Island. An additional 10 occurred elsewhere in BC. Accordingly, 57% of all North American interactions that resulted in injuries or death happened in the province (Beier 1991). Between 1900 and 2009, 8 people were killed by cougars in BC; although many believe otherwise, negative encounters with cougars have not recently increased in the province (*Figure 7*). We suspect that this perception might be driven in part by increasing media coverage.

Cougar predation constitutes a small proportion of livestock mortality. The BC government estimates that approximately 450 domestic livestock are killed each year by carnivores (some of which are cougars) (BC Ministry of Water, Land and Air Protection 2003).

Figure 7. Negative cougar-human encounters in BC during 1900-2009 (BC Ministry of Environment, unpublished data).



*A British Columbian
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human than by a cougar.*

Although reliable information is lacking, we think that the impact of BC cougars on domestic animals is very small, particularly in the context of abundance of cougars and livestock.

Many biologists and wildlife managers believe that acting proactively is far more effective than being reactive in terms of cougar-human conflict. The provincial government acknowledges that responding with lethal control to individual conflicts has not reduced wildlife-human conflict (BC Ministry of Water, Land and Air Protection 2003). Prevention might be a more effective strategy for protecting humans and cougars over the long term (BC Ministry of Water, Land and Air Protection 2003). Indeed, conservation scholars have argued that carnivore-human coexistence depends primarily on managing *human* behaviours (Clark and Rutherford 2005).

Importantly, no scientific evidence supports the idea that hunting reduces the risks of cougar-human conflicts. Indeed, some biologists have suggested that, in addition to increased human presence within cougar distribution, cougar-human conflict in BC and elsewhere might actually *increase* due to the younger age structure created by hunting. This is because young cougars are more likely to become involved in cougar-human conflict (Lambert et al. 2006). As they are less experienced and unfamiliar with new areas, dispersing subadults might find it difficult to kill wild prey and thus are apt to be involved in conflicts with people (Cougar Management Guidelines Working Group 2005).

As an alternative to lethal control and for the benefit of pets, livestock, and cougars, non-lethal strategies are available. Indeed, the only effective long-term strategies for reducing predation are improved strategies for pet safety and livestock husbandry (Cougar Management Guidelines Working Group 2005). To facilitate cougar-human coexistence, British Columbians need to accept the small degree of risk that cougar predation of domestic animals might occur and take appropriate precautions to reduce the likelihood of predation within cougar distribution. People who live, work, and recreate within cougar distribution should be responsible for learning about human safety with regard to cougars (Logan and Sweanor 2001). Notably, based on visitor questionnaire information, people who hike on Vancouver Island's West Coast Trail strongly support the use of non-lethal strategies for reducing cougar-human conflict (Carrow 2005). Whether those who tend livestock or hunt ungulate

prey would show similarly strong support is unlikely, and argues for increased educational efforts directed at these groups.

Clearly, this strategy requires science-informed education and awareness programs that will help reduce the likelihood of cougar-human conflict. Fortunately, many existing published resources provide information that leads to reduced risks of cougar-human conflict (e.g., Cougar Management Guidelines Working Group 2005). Notably, the provincial government has created cougar education and awareness materials (BC Fish and Wildlife 1994; BC Ministry of Water, Land and Air Protection 1996). Further, in Vancouver Island's Pacific Rim National Park Reserve of Canada, an ongoing initiative focuses on the coexistence of humans and large carnivores (Hansen and Carrow 2005).

In addition, if similar to other areas in North America, there might be strong interest among BC producers and consumers for 'predator-friendly' certification. Such certification of food and fibre products (e.g., wool, honey, meat, dairy, and eggs) would benefit humans, domestic animals, cougars, and other large carnivores in the province. As these products are produced using non-lethal strategies, they contribute toward predator-human coexistence (Predator Friendly 2009).

Ethical Considerations of Trophy Hunting and Lethal Control

Whereas many British Columbians support hunting animals like deer or moose for food, most do not support trophy hunting of large carnivores. We believe that cougars have inherent worth that supersedes their value as hunting trophies. These ethical considerations are sufficient to eliminate cougar hunting and significantly reduce lethal control of cougars in BC.

Conservation and management of BC cougars should take into account emerging ethics related to human-carnivore relationships. As Michael Nelson and Kelly Millenbah commented in their recent publication *The Ethics of Hunting*: ‘To the degree the wildlife community begins to take philosophy and ethics more seriously, both as a realm of expertise that can be acquired and as a critical dimension of wildlife conservation, many elements of wildlife conservation and management would look different’ (Nelson and Millenbah 2009). Importantly, the welfare of individual cougars is affected by hunting and lethal control. Conservation includes safeguarding the welfare of individuals that constitute the population. In our view, conservation and management of BC cougars ought to consider commonly held ethical values of British Columbians regarding biodiversity conservation and the welfare of individual cougars.

We suspect that many British Columbians are neither aware that cougars are hunted in the province nor of methods by which they are killed. Cougar hunting generally occurs in winter when tracks are visible in snow and trained dogs are used to trail cougars by scent. The likelihood of capturing a cougar with hounds is high (Spreadbury 1989; Logan and Sweanor 2001). As cougars have less endurance than dogs, they generally climb trees or bluffs to avoid hounds, which is a strategy that might have developed because cougars co-evolved with wolves (Hansen 1992; Logan and Sweanor 2001; Pierce and Bleich 2003). Once treed, cougars are captive prey and their death is essentially guaranteed. Cougar-hunting methods are increasingly

Conservation and management of BC cougars ought to consider commonly held ethical values of British Columbians regarding biodiversity conservation and the welfare of individual cougars.

including snowmobiles, all-terrain-vehicles, radio-telemetry to track hounds, and radios for communication among humans (Logan and Sweanor 2001). The lifeless bodies of cougars are skinned and decapitated for taxidermy trophies, including ‘life-sized’ mounts, head mounts, rugs, and skulls. Photographs and video are often taken of the treed and dead cougars and the people responsible for the killing.

A variety of reasons might be offered to suggest why we ought to hunt cougars. These reasons include tradition, recreation, trophies, population control, competition with humans over ungulates, promotion of cougar conservation, and the reduction of other cougar-human conflicts. However, it is highly implausible that any of these reasons, individually or collectively, are adequate to justify hunting cougars. Further, cougar hunting is likely to erode support for other acceptable forms of hunting.

Whereas many British Columbians support hunting for food, most do not support trophy hunting of large carnivores, including cougars. The main purposes of cougar hunting – as far as we can surmise – seem to relate to trophy, thrill, and self-esteem. Significantly, cougar meat is eaten only in exceptionally rare circumstances (Hansen 1992). We believe that it is morally indefensible to extinguish the life of an individual cougar for any reason other than an immediate threat to human safety. Others agree. Based on visitor questionnaire data, 76% of hikers on the West Coast Trail on Vancouver Island do not support cougar hunting (Carrow 2005). Significantly, we suspect that most hunters in BC do not support trophy hunting of large carnivores, including cougars. Notably, 78% of British Columbians oppose trophy hunting of grizzly bears on the central and north coasts of the province (Ipsos Public Affairs 2009). In addition, we believe that it is morally indefensible to harass cougars via pursuit-only hunting. Moreover, we suspect that most British Columbians – cougar hunters included – would agree with our view that it is morally indefensible to cause the orphaning, starvation, and death of cougar kittens for the trophy and thrill provided by killing their mothers.

Although lethal control of individual cougars related to human safety might be ethically acceptable in very rare circumstances, we believe that widespread lethal control related to predation of domestic animals and endangered prey is clearly unacceptable. We do not necessarily think, based on our values, that it is undesirable if cougars cause prey declines or maintain prey at low abundance.

One cannot favour prey over predator species. In addition, the effects of lethal control on large carnivore welfare are generally not considered in recovery planning for endangered species in BC. Given the suffering and killing that cougars would endure because of lethal control, which might not even benefit prey in the end, proceeding with such uncertainty ought to be considered unethical. Importantly, lethal control ignores the ultimate root of the conservation problems facing endangered prey by focusing on proximate causes. In our view, it is unethical that, when a species is endangered due to human activities, cougars are killed.

The ethical considerations we raise are alone sufficient to eliminate trophy hunting and significantly reduce lethal control of cougars in BC. This *can* occur in BC. Cougar hunting is illegal, for example, in California. Notably, this decision was reached on ethical considerations. Biologists have likewise suggested that the ‘extraordinary’ sentience of wolves is an ethical reason not to subject them to trophy hunting or lethal control (Haber 1996). We agree and, in our view, the same reasoning should be applied to cougars. We believe that cougars are more than simply numbers; they are complex, individual creatures. We consider cougars to be sentient beings that have inherent worth that supersedes their value as hunting trophies. We believe that British Columbians ought to recognize this and choose to eliminate cougar hunting in the province.

Conservation Assessment and Conservation Strategies

Conservation strategies should include: protection of remaining high-value habitat for cougars and their prey; elimination of cougar hunting; replacement of lethal control with non-lethal strategies; and education to reduce cougar-human conflict.

Conservation assessment

How do we assess the efficacy of cougar conservation efforts across the province? Are cougars adequately safeguarded? Do policies reflect the contemporary values of society? We start by noting the following: cougar management policies have not changed significantly since the cessation of bounties in the mid-1900s. Specifically, management policies focus on consumptive use (i.e., killing) and lethal control. As we outlined above, they do not incorporate in any depth measures to prevent – or even detect – population declines. Following through on published intentions to safeguard habitat or prey has likewise not occurred. Simply, BC cougars are managed only with respect to their exploitation and persecution. In addition, the myth that cougar hunting is a necessary part of conservation, which is a sentiment reflected in the ethos of BC management, creates division among people regarding cougar management (Papouchis et al. 2005). Fortunately, despite this approach to cougar management, a considerable amount of high-value habitat is left in the province. And importantly, there is the political capital in the form of public sentiment to make considerable changes to hunting regulations.

The potentially declining Vancouver Island cougar population – that the BC Ministry of Environment’s data have estimated – is a concern. Further, hunting regulations do not appear to be considering the small estimated population size and lack of connectivity to other cougar populations. Accordingly, the number of cougars killed for hunting and lethal control on the island might be high.

At present, though we suspect the forthcoming conservation plan by the provincial government will prove otherwise, management of cougars is ‘behind the times’, both scientifically and ethically. The province ought to bridge this gap between cougar science and cougar management. We hope this document and the information we summarize provides utility as a central resource to reach that goal.

The management of cougars in BC has not progressed at the same rate as the scientific understanding of cougar ecology. At present, though we suspect the forthcoming conservation plan by the provincial government will prove otherwise, management of cougars is ‘behind the times’, both scientifically and ethically. Further, there are few resources available to, or invested by, the provincial government to study BC cougars. Notably, many biologists have suggested that cougar research in BC has not been given the same priority by the provincial government as has been given to other species. A government employee, Hebert (1989) made a similar point more than two decades ago. Clearly, the province ought to bridge this gap between cougar science and cougar management. We hope this document and the information we summarize provides utility as a central resource to reach that goal.

Conservation strategies

We believe that the fundamental goal of conservation and management is to ensure the long-term maintenance of a viable, wild population of cougars in British Columbia. Given the daily erosion of habitat, gaps of data, and inherent uncertainty of even the best information, contemporary wildlife management has adopted a conservative approach to land and species conservation. This precautionary approach is a key operating principle for the transition to an active conservation plan.

In general, Raincoast advocates for science-informed conservation strategies that are well-grounded in sound environmental ethics. As we have emphasized, the fate of cougars ultimately depends on our ability to coexist with them at a local level. Any conservation strategy that fails to gain the acceptance, if not active participation, of local communities will be hampered from the beginning.

The following introduces a framework for a conservation and welfare plan for cougars in BC.

We specifically recommend:

1. Solicit and draw on traditional knowledge and wisdom of aboriginal people and local people;
2. Develop and maintain regular communication within local communities;
3. Foster a change in public attitudes regarding the ecological importance of maintaining healthy predator-prey systems;
4. Implement non-lethal strategies, including education, to reduce cougar-human conflict and lethal control of cougars;
5. Protect the remaining network of undisturbed and connected habitat for cougars and their prey:
 - Protect key habitats
 - Provide safe travel opportunities
 - Facilitate dispersal and population exchanges, which can potentially counteract the isolating effects of fragmentation
 - Provide for latitudinal or elevation movements in response to climate change;
6. Support applied ecological research;
7. Eliminate cougar hunting.

We do not support the trophy hunting of cougars. Just because British Columbians are currently allowed to hunt cougars does not mean they should. However, if British Columbians continue to sanction cougar hunting, then the best available science leads us to make the following recommendations:

1. Set low, male-only quotas for management units;
2. Establish large, no-hunting sanctuaries;
3. Eliminate pursuit-only hunting.

Research Priorities

Research priorities for BC cougars, which could use non-invasive tools, include: understanding the influences of habitat fragmentation on cougar-prey systems, and investigating the ecological, evolutionary, and ethical consequences of cougar hunting.

In addition to advocating for conservation grounded in science and ethics, Raincoast conducts scientific research – often in collaboration with universities. In the future – and if funding permits – we might consider a cougar study that examines some of the problems we outline below. Methods available to do so are varied. GPS collars, for example, can be used to study cougars. However, while it can provide high-quality data, collaring is invasive and can have negative effects on large carnivores (Cattet et al. 2008). If non-invasive and collaring research techniques can answer a similar set of questions, then the obvious ethical choice is non-invasive (Darimont et al. 2008). In lieu of collaring, non-invasive approaches, including molecular genetic and hormonal sampling techniques can be used. A suite of additional tools can also be employed, including digital remote cameras, track stations, backtracking in snow, and hair collection stations. In particular, we emphasize the need for long-term (i.e., over a period of 10 to 20 years), large-scale conservation research.

(Below) Cougar photographed by remote camera at night on the central coast of British Columbia (Raincoast Conservation Foundation).



Based on our assessment of information gaps regarding BC cougars, we propose the following research priorities:

- Identify the focal geographic region(s) for cougar management and conservation; highest-priority areas are likely Vancouver Island and the interior rainforest ecosystems;
- Review the ecological history of the focal region(s) to determine what changes have occurred in the landscape, especially since European settlement;
- Identify essential ecological requirements and long-term ecological processes that affect cougar abundance;
- Determine cougar provincial population and regional subpopulation conservation goals within the context of prey and habitat availability;
- Improve understanding of the implications of small population sizes;
- Examine conservation genetic parameters of Vancouver Island cougars;
- Understand the influences of logging and habitat fragmentation on cougar-prey systems, especially in coastal and inland rainforest (i.e., mountain caribou) habitat;
- Develop and improve non-invasive tools for monitoring BC cougar populations;
- Develop and initiate long-term monitoring methods to reveal temporal changes in population size and help to distinguish short-term fluctuations from long-term declines;
- Determine maximum sustainable annual mortality rates for cougars;
- Incorporate a system to regulate non-natural deaths;
- Test the efficacy of non-lethal strategies for reducing cougar-human conflict;
- Investigate the ecological, evolutionary, and ethical consequences of cougar hunting on the welfare of individuals and population persistence, particularly on Vancouver Island.

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