Title
Sharing the range: managing wildlife impacts to livestock production in California Coast Range working landscapes

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Abstract
Livestock and wildlife share grazed rangelands, and in many cases, they get along fine. Some wildlife species, however, can negatively impact livestock operations by killing livestock, consuming forage, damaging facilities, and transmitting disease. Ranchers have traditionally resorted to lethal wildlife control to reduce these impacts, yet this has been controversial as many people do not want any animal to be harmed for any reason. In addition, some policies designed to protect wildlife may be perceived by ranchers as doing so at the expense of livestock production. It is important to find ways to minimize the conflicts between livestock production and wildlife protection in order to maintain sustainable working landscapes that enjoy broad support among livestock producers and conservationists.

Interviews of people connected with livestock production in and adjacent to the California Coast Ranges, from Mendocino County south to Monterey County, and a review of scientific literature were used to identify the main problems ranchers experience with wildlife and the impact reduction strategies they use that are broadly acceptable to the public. Interviewees most commonly described grievances related to the mountain lion, tule elk, coyote, California ground squirrel, and feral pig. For each of these species, a history of popular opinion in California is summarized, ecological and biological characteristics are briefly reviewed, impacts to livestock operations are described, dimensions of lethal control are outlined, and strategies used to reduce impacts with minimal controversy are assessed for their effectiveness. Informed by and written for ranchers and range managers, this paper can be used to plan for potential wildlife impacts, understand the controversy over lethal control, determine viable strategies to manage wildlife impacts with minimal controversy, and find references and resources.

Overview
Californians have come to expect the state's rangelands to provide wildlife habitat along with livestock products, and in many cases, both expectations can be met with minimal conflict (Huntsinger and Sayre 2007). Problems can arise for livestock producers, however, when wild animals kill livestock, compete with them for forage, damage facilities, and transmit disease. Lethal control, the wildlife management strategy traditionally used by ranchers, can be controversial, especially when it targets a population rather than an individual problem animal. On the other hand, policies that have been developed to protect wildlife can aggravate the situation for livestock producers by increasing costs, and from their perspective, benefiting wildlife to the detriment of livestock production. Despite these issues, many conservationists as well as ranchers believe that "working landscapes", with producers using and stewarding the

land, are the best hope for large scale wildlife habitat conservation in the state. Moreover, livestock grazing is critical to many native plant and animal species valued by Californians (Barry et al. 2006, Ford et al. 2013). It is important to find ways to minimize conflicts between livestock production and wildlife protection in order to maintain sustainable working landscapes.

This paper is the result of an attempt to better understand issues that arise from wildlife and livestock sharing the rangelands of the California Coast Ranges: how wildlife can become a problem for livestock producers, how those producers interact with wildlife in response, and what strategies are being used to manage wildlife impacts with minimal controversy. To explore these questions, ranchers, rangeland agency staff, hunters, and range management consultants were interviewed; pertinent scientific literature was reviewed; and articles from the popular press about wildlife—livestock conflicts were consulted.

The interviewees consistently identified five wildlife species that impact livestock operations in Coast Range working landscapes. They were the mountain lion (*Puma concolor*), tule elk (*Cervus elaphus nannodes)*, coyote (*Canis latrans)*, California ground squirrel (*Spermophilus beecheyi*), and feral pig (*Sus scrofa*). Other species – badgers, pigeons, rattlesnakes, and ravens – were mentioned, but not as consistently. Below, after a description of data collection methods and geographic context, case studies about the five regularly mentioned species are used to describe and discuss wildlife-related problems and the strategies employed to deal with them. The paper concludes with a review of the most promising management strategies for each species. Designed to be a resource for range managers, this paper can be used to anticipate potential wildlife impacts, learn about low-controversy impact reduction strategies, and find relevant resources.

Interview and literature review methods

Twelve people who participate in range management from Mendocino County south to Monterey County were interviewed. They were ranchers (5), independent range management consultants (4), range managers in government agencies (2), and private lands hunters (1). Interviews were 15 to 45 minutes in length and were mostly conducted via telephone. An open-ended approach was used to gather information, with questions such as “Do livestock producers in your area experience problems with wildlife?” This approach allowed the interviewees to frame their perceptions and experiences in their own terms and for new ideas and leads to emerge throughout the study (Sayre 2004).

Data from the interviews shaped the direction and focus of the literature review. Sources were reviewed and referenced if they provided information on natural history or population dynamics of the focal wildlife species, or if they shed light on wildlife problems experienced by Coast Range livestock producers, the controversies surrounding lethal wildlife control, or the strategies being used to mitigate problems. A total of 128 sources were reviewed and referenced. These included 63 articles published in peer-reviewed journals, 25 technical reports by university and government entities, 18 books and book chapters, 8 conference proceedings, and 4 doctoral and master’s theses. Ten offerings from the popular press were also consulted,

but only to enhance understanding of livestock—wildlife conflicts and conflict mitigation.

Geographic context

The California Coast Ranges span from the Oregon border to the Transverse Ranges, with the San Francisco Bay separating California's Northern Coast Ranges and Southern Coast Ranges. The ranges comprise a great assortment of lithologic materials and geologic processes. During subduction, chunks of seafloor were scraped off from the Pacific Plate and accreted to the Continental Plate, and subsequent uplift, faulting, and folding have resulted in further variation (Harden 2004). Slopes range from steep to gentle, with evenly spaced ridges and valleys a regular feature due to erosional processes (Perron et al. 2009). Soil heterogeneity reflects the variability in geology and topography, but Mollisols – "grassland soils" with thick, dark top soils – are common (O'Geen and Arroues 2013). The rangelands of the California Coast Ranges are typically mosaics of oak and bay woodlands, chaparral, and grassland (George 2013). Overall, the climate is Mediterranean, but close to the coast, a maritime influence tempers the hot dry summers and results in continued growth when the vegetation in rangelands in most of the rest of the state is dry (Ford and Hayes 2007). Wildlife impacts covered in the case studies that follow reflect interviews of people connected to livestock production on the slopes and adjacent flats of the Coast Ranges from Mendocino County south to Monterey County, but strategies discussed here may apply to comparable environments farther to the north and south.

Mountain lion

The mountain lion — also known as catamount, and cougar — is native to North America. Before European settlement, it inhabited the lower 48 United States. The first bounty for its lethal removal was recorded in Lower California in the late 16th Century, when Jesuit priests offered a bull for each mountain lion kill. Extensive lethal control subsequently relegated them to the Southwest, Rocky Mountains, and Pacific Coast Ranges (Young and Goldman 1946). With the abandonment of bounty programs and the adoption of legislative protections in the 20th Century, their numbers have increased and their range has expanded (Culver et al. 2000). This expansion has coincided with a general perception by ranchers that mountain lion predation of livestock is increasing. Lethal control has become controversial, however, because the conservation of the mountain lion results in the conservation of other species that share its habitat (Thorne et al. 2006, Estes et al. 2011). It is also valued as an indicator of linkage areas in fragmented landscapes (Dickson and Beier 2007) and a charismatic symbol of wilderness (Bolgiano 1995).

Distribution, abundance, and behavior

In California, mountain lions are currently found in the Coast Ranges, Sierra Nevada, deserts east of the Sierra, and suburban areas. Their home ranges are large, spanning hundreds of square kilometers, and vary by region, sex, and season (Grigione et al. 2002). They prefer shrublands and forests over grasslands, likely because of the cover they provide (Wilmers et al. 2013).

An accurate census of the statewide population is challenging due to their elusiveness,

potentially dangerous behavior, and extensive ranges (Wolch et al. 1997, Ernest et al. 2003). Nonetheless, estimates have been generated, from 600 in the 1920's (Fimrite 2013), to 2400 in the 1970's (Sitton 1973), to 5100 in 1989 (Mansfield and Weaver 1989), to 4000-6000 in the 2000s (CDFG 2007).

Mountain lions rely mainly on large ungulate prey for survival and reproduction. In the Santa Cruz Mountains population, for example, each adult lion kills approximately one deer per week (Wilmers et al. 2013). Though they typically travel and hunt at night, from 1986-2013 there were 14 verified attacks on humans in California, three of them fatal (CDFW 2014*a*).

Research indicates that the predatory behavior of mountain lions is not simply opportunistic or indiscriminate, but instead is the result of balancing risk with reward (Brown and Kotler 2004). For instance, young, less experienced mountain lions are more likely to take risks than older ones. Also, mothers with cubs are more likely to take risks in order to feed their young (Wilmers et al. 2013). When teaching her young to hunt, a mother lion may increase kills (Fitzhugh and Gorenzel 1986). In that vein, one interviewee regularly observed a mother lion and her three cubs in the same area. That mother killed cattle, and her young learned to do the same.

Impacts to livestock production

An agency range manager explained in an interview that "...there has been a huge increase in the mountain lion population. Development encroaches and boxes them in. Fewer corridors [exist], [and there are] no predators except for cars on the highway. Cattle make an easy prey source." In 2010, 1400 head of cattle and 8300 calves were lost to predators in California. Mountain lions and bobcats were responsible for 32% of the lost cattle and 12% of the lost calves (USDA NASS 2011*a*). This loss represents just <0.1% of the cattle in the state in 2010 (USDA NASS 2012), but was problematic for individual producers, especially those with narrow profit margins (Mitchell et al. 2004). One rancher interviewee – who had recently lost six head of cattle to mountain lions out of a herd of fifty – noted that the worst losses happen to first-calf heifers, which are not as protective of their young as older mother cows. When asked about mountain lion predation of livestock in an interview, an agency manager urged that the full picture of economic loss be considered. For instance, if a grazing lessee loses a calf from a cow-calf pair, the lessee must pay a whole year's rent for grazing land for the cow before she bears another calf. Also, lion chases result in livestock weight loss, and then income lost at sale (interviewee).

Lethal control

Reflecting public opinion, the legal status of mountain lions changed several times in California during the 20th Century (Fitzhugh and Gorenzel 1986, Wolch et al. 1997). From 1907 to 1963, it was a bountied predator; from 1963 to 1969, it was a nongame animal that could be hunted and killed year-round with no limit; from 1969 to 1972, it was a game mammal with hunting seasons and take limits; and from 1972 to 1990, it was protected from hunting by a series of moratoria (Mansfield and Torres 1994). When the California Department of Fish and Game attempted to reclassify it as a game animal in 1986 and 1987, animal protection groups filed suit against the state, which eventually led to the 1990 passage of Proposition 117, the Wildlife

Protection Act (Koch 1994). This act classified the mountain lion as a Specially Protected Species with full protection from hunting (Fish and Game Code §4800) and stipulated that money be set aside for protection of wildlife habitat and wetlands (Koch 1994).

Today, the California Department of Fish and Wildlife (CDFW, formerly the California Department of Fish and Game) and other authorized agencies may, without a permit, legally dispatch a mountain lion perceived to be a safety threat to humans or bighorn sheep (§4801). Fueled by the CDFW shooting of two mountain lion kittens in Half Moon Bay in December 2012, mountain lion protection groups campaigned for legislation which requires that the agencies use nonlethal means, especially relocation, whenever possible when responding to mountain lion safety concerns. The California Cattlemen's Association (CCA) officially opposed the legislation as of April 2013, concerned that mountain lion relocation would increase the risk of livestock kills (http://www.leginfo.ca.gov/). According to a press release from the Mountain Lion Foundation (August 26, 2013), the CCA withdrew its opposition after working with the Mountain Lion Foundation to craft the text of the bill. In September 2013, the bill (SB 132) was signed into law (§4801.5).

Livestock owners seeking to kill a mountain lion that has injured or killed livestock must request a depredation permit from the CDFW (§4802). The CDFW or authorized agency will issue a permit orally immediately or after confirming that a lion made the kill (§4803; §4805). The permittee must report injuring or killing the mountain lion as soon as possible and make arrangements to turn over the carcass in a timely manner (§4806). Between 1972 and 2013, 6175 permits were issued, and 2816 mountain lions were taken, with an annual average of 67 (±46 standard deviation; CDFW 2014*b*). Using a statewide population estimate of 5000 (CDFG 2007), this average take represents about 1.3% of the population.

In contrast to the efforts of mountain lion protection groups that led to the 2013 adoption of the legislation that restricted the CDFW's response to mountain lion public safety threats, no evidence of protests about depredation permits was found. Ranchers, however, expressed frustration about their restricted ability to deal with mountain lions, and the irony that it was urbanites, who seldom deal directly with mountain lions, who brought forth the restrictive, protective legislation. As one interviewee stated, "Ranchers are supposed to be okay with them, but they cause all kinds of alarm when you see them near a city. Kind of two-faced." The Monterey *Herald* captured this sentiment in 2009, when it reported that 'A revolt is brewing on the rangelands of San Benito and Monterey counties over state game laws that protect mountain lions' (Howe 2009). Ranchers and farmers were described as frustrated with predation on deer and livestock by protected mountain lions, and resentful of voters from San Francisco and Los Angeles who supported the Wildlife Protection Act, but who had not seen mountain lions outside of zoos or television programs. As reported in the article, at a 2009 public forum held by the San Benito County Fish and Game Advisory Commission, a San Benito County Supervisor lamented that his constituents were worried about prosecution if they could not justify lethally removing a mountain lion from their grazing lands. He said that as a result they tend to adopt the "three-S" principle of "shoot, shovel, and shut up" (Howe 2009). Two interviewees also mentioned this phenomenon.

One interviewee also mentioned the additional constraints experienced by grazing lessees on public lands. Graziers leasing from particular agencies may not request depredation permits, and accordingly their set of tools is restricted even further (interviewee).

Summing up the complex challenges surrounding mountain lions and livestock sharing Coast Range grazing lands, one interviewee commented, “No one wants to touch the mountain lion issue.”

Managing impacts with minimal controversy

The most effective strategy for reducing mountain lion problems may be regional planning that anticipates the behaviors of mountain lions and locates ranches and other human constructs out of their way. An example of research that can inform such planning is the Santa Cruz Puma Project based at UC Santa Cruz. The project seeks to determine the spatial scale and level of fragmentation associated with mountain lion behaviors of traveling, feeding, communicating, and maintaining dens. Using this information, researchers have identified movement corridors and mapped areas where conflicts among mountain lions, humans, and livestock will most likely occur. Such maps can be used to inform regional planning and help producers understand their risk of predation (Wilmers et al. 2013). While this sort of work requires much time and financial support, it is promising for building consensus around mountain lion management over the long term.

In the meantime, before regional planning that incorporates mountain lion behaviors and distribution takes effect, some producers may be able to use nonlethal exclusion to reduce livestock kills with minimal controversy. Marin and Sonoma County sheep producers surveyed by UC Cooperative Extension staff reported that electric fencing and shepherding was effective against mountain lion predation at ranches over 1000 acres, while guard dogs, night pastures, and lambing in sheds was effective at smaller ranches (Larson and Salmon 1988). In contrast, other representatives of UC Cooperative Extension warned that guard animals are not effective or practical for protecting livestock from mountain lions (Fitzhugh and Gorenzel 1986). One agency range manager described an approach to nonlethal exclusion that entails moving stock from pastures known to be at risk of mountain lion predation. The manager noted that this is an effective strategy when water and forage are available in lion-free pastures (interviewee).

The idea of monetary compensation for livestock losses due to mountain lions was appealing to some interviewees. One rancher explained that “There are losses in any business, but at least have it be a balance with some restitution.” One public grazing lease agency has initiated a program to reimburse lessees for livestock losses due to predation on agency grazing lands. Because the program is new, effectiveness of this strategy could not be assessed.

Tule elk

The tule elk is a subspecies of North American elk endemic to California. Upon European arrival, its range spanned the entire Central Valley and included the Coast Ranges and foothills of the Sierra Nevada (McCullough 1969). The total herd was estimated to number 500,000, with

individual herds numbering in the thousands (McCullough 1969, McCullough et al. 1996). Just decades after the Gold Rush, habitat conversion and market hunting had reduced the species to a single population of less than twenty individuals on the Miller and Lux Ranch in the southern San Joaquin Valley (Koch 1994, McCullough et al. 1996). Henry Miller provided an early example of a rancher working to benefit wildlife when he banned tule elk hunting on the ranch and later provided land for the first tule elk reserve (McCullough et al. 1996). Since then, twenty-one groups have been relocated from reserves to the open range, with a total estimated number of 3800 (CDFW 2014*c*). By 1987, at least twelve of the state's relocated groups had significantly damaged private property (CDFW 2014*d*). Like ranchers faced with mountain lion problems, those with tule elk problems have a limited set of tools for excluding or eradicating this prized native mammal from grazing lands.

Distribution, abundance, and behavior

Major populations of tule elk are found in the Northern Coast Ranges in eastern Mendocino County, Lake County, and western Glenn and Colusa counties. Closer to the Bay Area, they inhabit the Point Reyes National Seashore, Grizzly Island of Solano County, and the Mount Hamilton area of Santa Clara County. Further south in the Coast Ranges, they live in Monterey, San Benito, and San Luis Obispo counties (CDFW 2014*e*).

Their typical home ranges cover 217 ha (Cobb 2010) to 420 ha (Gogan 1986), which is small compared to other North American elk. Tule elk grazing can significantly impact plant community composition and production (Johnson and Cushman 2007). At 300 to 500 lbs, they eat 2.5 to 3% of their body weight each day (Bayless 1998).

Due to its near-extinction in the 19th Century, the tule elk has experienced inbreeding and probable loss of genetic diversity, but its behavioral plasticity has allowed it to reproduce exponentially in the absence of over-hunting in suitable habitats (McCullough et al. 1996). Because of this reproductive capacity, population size can quickly reach or exceed local carrying capacity (McCullough 1969, Bartolome 1993, Howell et al. 2002).

Like cattle, tule elk select forage by balancing the lowest output of energy with the highest possible nutritive gain (Pomeroy 1986, Jackson and Bartolome 2007). On the whole, both species tend to prefer grasses over other plant functional groups (Jackson and Bartolome 2007). Studies of the interactions of tule elk and cattle have shown that their preferences and effects on each other's behavior are site- and season-specific (Gogan 1986, Pomeroy 1986, Gogan and Barrett 1987, Cobb 2010).

Impacts to livestock production

Tule elk transplanted from captivity to new ranges can damage fences, consume livestock forage, and transmit disease to livestock (Ciriacy-Wantrup and Phillips 1970, McCullough et al. 1996, Kimmey 2014). One rancher explained that "Tule elk are attracted to cattle ranching and can roam far to access it." Another stated, "They are extremely hard on fences. They don't jump them, they just run right through."

At the Point Reyes National Seashore, there has been discord between National Park Service goals for tule elk conservation and dairy producer goals for production, to varying degrees since the 1980s (Bayless 1998). In 1978, ten tule elk were imported into a 1050 ha enclosure on Tomales Point, at the northern end of the seashore (Bayless 1998). In 1998, when the captive population had grown to approximately 450, Point Reyes biologists relocated a small group to the Limantour Wilderness at the southern end of the park. Shortly after their relocation to the wilderness area, two or three individuals traveled approximately 10 km west and established a third group on an active dairy cattle ranch in the Seashore's pastoral zone (Cobb 2010). In a May 2014 public forum, two pastoral zone ranchers reported that groups permanently reside on their ranches, one numbering 80 and the other numbering 45 (Kimmey 2014). A population model predicted that the group in the pastoral zone could grow to about 400 individuals by 2018 (Cobb 2010), but Point Reyes National Seashore ecologists have not officially approved or adopted this estimate (Kimmey 2014).

Organic production is the norm at dairies in Marin and Sonoma Counties and seems to be quite important to the survival of the industry there. A range management consultant interviewee explained that in Marin and Sonoma, "Most dairies have gone organic or gone out of business." The costs of organic production are high, and tule elk can exacerbate this situation for producers. For example, during the three- to four-year transition period from a conventional to a certified organic dairy herd and pasture, the producer must sell lower priced conventional milk yet pay costs for the transition (interviewee). Also, to maintain their organic certification, dairy producers must graze their cattle on organic pasture for the last third of the gestation period (USDA Organic 2012) – about 120 days for the cows in Marin (personal communication, Point Reyes dairy rancher). The tule elk in the Point Reyes pastoral zone are breaking fence to eat organic supplemental feed and forage intended for dairy cattle, which requires producers to purchase more organic supplemental feed or keep cows on organic pasture longer than planned (interviewees).

Along with competition for forage, disease transmission is also a concern at Point Reyes. All ruminants are susceptible to paratuberculosis, also known as Johne's disease, a chronic granulomatous enteritis or "wasting disease" (Manning et al. 2003). Deer, cattle, and tule elk at Point Reyes have tested positive for the infection (Riemann et al. 1979, Gogan and Barrett 1987, Manning et al. 2003, Crawford et al. 2006). Transmission is possible between these species, usually through fecal matter (Bayless 1998). Unfortunately, tests for the disease are costly and have a high incidence of false negative results (interviewees).

Lethal control

Tule elk transplanted from a reserve to the Owens Valley in the 1930s became a focal point for controversy over lethal control during the 20th Century. Their damage to fences, alfalfa fields, and water developments motivated local ranchers to press for their lethal control or removal. Bitter debate arose between the ranchers and the parties who demanded elk protection, even if it meant removing ranching from the landscape (McCullough et al. 1996, CDFW 2014*d*). Meanwhile, seven hunts were conducted in the Owens Valley in 1943 through 1969, with neither party satisfied with the hunts' effects on tule elk dynamics. Opposition to the hunts

grew, and, in 1960, the Committee for the Preservation of Tule Elk was formed (CDFW 2014*d*). Due in large part to the efforts of that committee, the California State Legislature passed the Behr Bill, which prohibited the take of tule elk unless the statewide population exceeded 2000 (CDFW 2014*d*). Five years later, the United States Congress passed Public Law 94-389, which upheld the Behr Bill and made provisions for tule elk re-introduction into suitable areas (McCullough et al. 1996, CDFW 2014*d*). Since 1989, when the population exceeded 2500 in 19 herds, limited sport hunting has been sanctioned for specific groups (Koch 1994, McCullough et al. 1996). No hunting has been sanctioned at Point Reyes (Bayless 1998, CDFW 2014*e*).

Managing impacts with minimal controversy

Landowners with tule elk grievances can work with the CDFW to purchase multiple tule elk hunting tags and sell them to hunters for use on their properties (interviewee). As of 2014, thirty-four ranches are participating in the CDFW's Private Lands Management Program, through which participants receive greater flexibility in the wildlife harvest in exchange for enhancing habitat and maintaining wildlife management plans (Macaulay et al. 2013, CDFW 2014*f*). Interviews and reviewed literature revealed three possible deterrents to tule elk hunting programs on private lands in the California Coast Ranges. One rancher said tags can be lucrative, sold for up to $15,000 per tag, but difficult to procure from CDFW. The rancher commented that "Fish and Game is very stingy to let private landowners [only] sell a few tags to offset costs." Moreover, ranchers interviewed by a local popular news source and for this paper suggested that establishing hunting programs requires ranchers to shift their focus from raising livestock to raising tule elk (interviewee, KQED Quest 2007). Correspondingly, another rancher interviewee relayed that while fee hunting may help reduce elk damage on the scale of a single ranch, it can negatively impact the ranching community by diminishing grazing lease opportunities on lands where the owners switch their focus from cattle to tule elk.

Where fee hunting is not desirable or feasible, nonlethal exclusion may be an effective and low-controversy way to reduce impacts. One interviewee asserted that the diligent upkeep and repair of old fences can keep livestock in and tule elk out. Another suggested that keeping the top strand taut is critical to tule elk exclusion. A third contended that for optimal livestock protection and wildlife mobility, livestock operators should maintain barbed wire fencing on the perimeter of properties and wildlife-friendly fencing within properties. A CDFW representative recommended strategically placing highly visible elk-friendly crossings, such as gates with cross braces, where elk most typically cross fencelines to reduce fence damage (personal communication). One rancher interviewee concurred, saying that he has noticed that tule elk typically cross in one area. That rancher plans to build the fences lower in those areas, "with the hope the elk will simply jump over the fence rather than charge through."

In the Point Reyes pastoral zone, fee hunting is not an option. Instead, the National Park Service has offered to help repair fences, furnish fence repair supplies, and create ponds to attract elk away from dairy pastures (Kimmey 2014). Contraception has also been suggested and studied, but has not been widely implemented. In addition, relocation is unlikely due to the prevalence of Johne's disease, the lack of reliable test results, and the CDFWs concern about disease spreading to other populations (Bayless 1998). Accordingly, the alternatives to lethal control –

fence repair, contraception, and relocation – have not yet significantly ameliorated the conflicts between cattle production goals and tule elk conservation goals at Point Reyes.

Coyote

The coyote, though native to western North America, may be cherished less widely than the mountain lion or tule elk. However, its advocates have worked to make some forms of lethal control illegal and others controversial. Today, they may be legally killed on sight, but only with methods restricted by federal, state, and local laws. These developments have resulted in changes to sheep ranching.

Distribution, abundance, and behavior

Though coyotes have been harassed, shot, and poisoned extensively in California since the Gold Rush, their abundance and range have increased over the past fifty years. This increase stems in part from their adaptability and ability to live in urban and suburban environments. They have diverse diets and variable social structures, living alone, in pairs, or in packs of up to ten. Found in all of California's major habitat types, their populations reach their highest densities in Southern California suburbs (Timm et al. 2007). Interviewees suggested that coyote numbers are also increasing on grazed rangelands. One agency range manager commented that "Ranchers are saying there are more coyotes now than in the past. "

In response to lethal control, coyotes increase reproduction rates, litter size, and survival rates (Knowlton et al. 1999). A population model generated at the UC Hopland Field Station predicted that a population could sustain itself despite annual removal of 70% of its individuals (Connolly and Longhurst 1975).

Though one interviewee described coyote behavior that was bold and aggressive on grazing land in Contra Costa County, on the whole they avoid humans (Timm et al. 2007). Coyotes that prey on livestock are typically older males and their female mates or breeding "alpha" coyotes with sheep in their territories (Connolly et al. 1976, Sacks et al. 1999*b*, Jaeger et al. 2001, Blejwas et al. 2002, but see Pearson and Caroline 1981)

Impacts to livestock production

Coyotes impact various types of agriculture in California, but their predation of livestock is the greatest concern among professionals who work with agricultural producers across the state (Baldwin et al. 2013). In 2010, 0.5% of the statewide cattle herd was lost to coyotes (USDA NASS 2011*a*, *b*). The coyote's toll on sheep production has been higher (Mitchell et al. 2004), with approximately 1.4% of the state's total sheep flock lost to coyotes in 2009 (estimated using USDA NASS 2000, 2012). Coyotes killed 2.1% of the UC Hopland Field Station flock on average each year from 1973 to 1984 (Scrivner et al. 1985). In Sonoma County between 1960 and 1985, sheep numbers declined from an estimated 143,000 to 27,000, and coyotes were thought to be responsible for 10-20% of that decline (Larson and Salmon 1988). An independent range management consultant interviewee said that in Marin and Sonoma counties, "Predation is why almost no sheep ranchers are in business."

Lethal control

Coyote control is selective when its aim is removing individuals with specific behaviors and nonselective when it is designed to reduce a population at large (Jaeger et al. 2001, Mitchell et al. 2004). An example of a selective control method is the livestock protection collar that emits fatal poison to the coyote attempting to puncture the neck of the sheep wearing the collar (Timm and Connolly 2001). Another form of selective control is to kill the pups of coyotes that have preyed on livestock, usually alpha coyotes or older males and their female mates. Coyote calling is another form of selective control, which entails luring coyotes by imitating their howls and the sounds of their prey using reed-callers or electronic recordings and then shooting them (Mitchell et al. 2004). In contrast, aerial shooting is a form of nonselective control, though it is usually inappropriate for the rugged terrain and dense vegetation of Californian Coast Ranges (Blejwas et al. 2002). The typical nonselective approach for California range has been placing leg-hold traps, snares, and/or cyanide (M-44) ejectors in areas known to be used by coyotes (interviewee, Jaeger et al. 2001).

Long-term study indicates that nonselective control is less effective at reducing livestock death loss due to coyote predation than selective control (Conner et al. 1998, Jaeger et al. 2001, Mitchell et al. 2004). The nonselective approach is less effective because it tends to impact young and less experienced coyotes that do not typically prey on livestock (Sacks et al. 1999*a*). Also, coyote responses to nonselective control – immigration from adjacent areas and increased reproduction rates, litter size, and survival rates – can result in increased livestock kills in some situations (Knowlton et al. 1999). On the other hand, selectively killing pups of a predatory alpha coyote can reduce sheep kills by 88%, and killing pups and their predatory parental breeding pair can reduce kills by 98% (Till and Knowlton 1983 referenced by Mitchell et al. 2004). In a pilot study at Hopland Field Station in the late 1990s, the selective livestock protection collar showed considerable promise in reducing livestock lost to coyotes (Timm and Connolly 2001).

In November 1998, Californians banned many forms of lethal control with the passage of state Proposition 4. The steel-jaw leghold traps, snares, and sodium cyanide for cyanide (M-44) ejectors used in nonselective control were banned (Associated Press 2001, Mitchell et al. 2004, Timm et al. 2007). Also banned was the only poison sanctioned by the Environmental Protection Agency for use in the livestock protection collar, sodium fluoroacetate, which is also known as “1080” (Timm and Connolly 2001).

Marin County sheep ranching has been impacted significantly by controversy over lethal coyote control methods. In 1989, Marin County initiated a contract for lethal coyote control with trappers from the United States Department of Agriculture’s Wildlife Services, in response to annual sheep death losses by coyotes of 5% and greater (Carlsen 2006). From 1998 through 2001, animal rights activists staged protests over the contract, and in response, the county terminated it in 2000 (Carlsen 2006, Fimrite 2012). In addition, in 1997, Marin, Sonoma, and Mendocino counties initiated the Livestock Protection Collar Pilot Project to investigate the viability of its wide use (Carlsen 2006), but the program was abandoned due to the Proposition 4 ban on sodium fluoroacetate. In response to the controversy over lethal control and the need

to protect sheep from predation, the county launched the Marin County Livestock Protection Program in October 2001 (Carlsen 2006). This program is described in the following section.

Managing impacts with minimal controversy

Selective lethal control, as discussed above, can reduce coyote impacts to livestock grazing with less controversy than nonselective lethal control (Jaeger et al. 2001). Another major low-controversy approach is keeping them away from livestock using nonlethal means. Four major tactics are typically used to discourage coyotes from entering livestock pastures or bedding areas. One is tailoring husbandry practices to attract fewer coyotes: conducting lambing in sheds, shepherding livestock during the day, bedding animals near humans at night in lighted corrals, and promptly disposing of carcasses (Robel et al. 1981, Conover 2002). Another is using guard animals, including dogs, llamas, and donkeys, to deter coyotes (Andelt 2004). A third method is constructing coyote-proof fencing, which typically requires electrified wire, as coyotes can scale over, slip through, and dig under conventional fences (Timm et al. 2007). Using flashing lights and loud noises to scare coyotes is the fourth major method (Mitchell et al. 2004).

A 1988 survey of sheep producers in Sonoma and Marin counties revealed the conditions in which these exclusion tactics were effective (Larson and Salmon 1988). In northwestern Sonoma County, where ranches exceeded 1000 acres, electric fencing and shepherding were considered effective. Guard dogs were not effective because the grazing area size was too large. At the smaller ranches of the Sonoma Mountains and its adjacent flats, ranchers reported that effective methods were guard dogs, bedding sheep in night pastures, and lambing in sheds. Scare devices were not emphasized by survey respondents, and indeed research indicates that these methods are typically ineffective because coyotes quickly learn to ignore them within weeks to months after exposure (Mitchell et al. 2004, Timm et al. 2007). Further, in an interview, one rancher cautioned that these devices can be counter-productive to the stewardship of other valued wildlife species. Cost-effectiveness must also be considered, because integrating any of these nonlethal methods into a livestock operation requires expenditure of significant time and money, especially initially (Shivik 2006).

The Marin County Livestock Protection Program is an example of an effective and low-controversy strategy to reduce wildlife impacts to livestock operations. The program pays producers half of the costs for electric exclusion fences, shepherding, guardian dogs and llamas, and scare devices (http://www.marincounty.org/depts/ag/livestock-protection). It also reimburses ranchers for herd losses of up to 5% if coyote predation can be proven (Agocs 2007). As of 2012, 26 ranchers were participating, representing all of the major sheep producers in the county. The number of sheep killed by coyotes in Marin has decreased steadily since the program began (Fimrite 2012). It is also cost-effective. The program, at $50,000/year, costs less than the former contract with USDA Wildlife Services for lethal coyote control, which cost $74,000/year (Carlsen 2005).

California ground squirrel

During most of the 20th Century, California ground squirrels were considered pests with no

value whatsoever. Toward the end of the century, however, scientists (and then some ranchers and land managers) began to appreciate ground squirrels' ecological value. Although they are still considered to be agricultural pests (Marsh 1998, Baldwin et al. 2013, Vertebrate Pest Control Research Advisory Committee 2013), it is now also recognized that they also serve as prey for valued carnivores (Lidicker 1989), act as critical agents of soil bioturbation (Schiffman 2007), and provide burrows for valued animals, including the federally threatened California red-legged frog (*Rana draytonii*) and California tiger salamander (*Ambystoma californiense*; Ford et al. 2013). Due to these keystone roles, nonselective California ground squirrel control has become more controversial (Lenihan 2007, Wong 2008, Davidson et al. 2012, Ford et al. 2013). One rancher commented on this discrepancy in an interview, saying, "I can understand that they make soil and provide habitat for other species, but lots of people don't like them."

Distribution, abundance, and behavior

The earliest explorers to California observed ground squirrels in great number (Schiffman 2007), and they persist in high abundance in Californian grasslands except in the Owens Valley, hot deserts (Vertebrate Pest Control Research Advisory Committee 2013), and rangelands directly adjacent to the coast (interviewee). They typically inhabit areas with open cover (Fehmi et al. 2005), live in colonies, and develop complex burrow systems (Evans and Holdenried 1943, Barry et al. 2006).

The continual success of the species has been linked to crop agriculture across the California landscape. Agricultural practices that favor squirrels include converting wetlands into drier farmlands, using sprinkler or drip irrigation instead of flood irrigation, and no-till farming (Marsh 1998). One range management consultant interviewee also said that "Ground squirrels have a lot to do with the underlying management of the land," and suggested that high ground squirrel abundance in California is the result of the pervasive and persistent annual grassland. On the other hand, on a smaller spatial scale, a study conducted over four years in the blue oak savannah of the East Bay Regional Park District's Del Valle Park revealed that ground squirrel activity declined more in open annual grassland pastures than in pastures with oaks (Bartolome 1997). While no single driver of the discrepancy could be isolated, hypothesized reasons included lower litter levels and herbaceous species composition preferred by squirrels in the pastures with oaks.

While light to moderate cattle grazing intensity does not appear to affect ground squirrel population dynamics on Coast Range working landscapes (Bartolome 1997, Fehmi et al. 2005), heavy stocking rates have been linked to an increase in ground squirrel abundance (Barry et al. 2006).

Impacts to livestock production

California ground squirrels impact livestock production by consuming forage (Evans and Holdenried 1943, Fitch 1948, Howard 1953, Baldwin et al. 2013), by damaging pasture through bioturbation and trampling (Marsh 1998), and by creating burrows that can injure the legs of cattle and horses (interviewees, Marsh 1998). In Madera County in 1951-1952, the daily weight gain of heifers was 1.03 pounds greater in a squirrel-free pasture than in a pasture with

approximately four squirrels per grazable acre (Howard et al. 1959). While no studies quantifying livestock leg injury due to California ground squirrels could be found, two interviewed ranchers mentioned that the burrows posed a very real hazard.

The policies of regional public agencies that lease grazing lands tend to protect ground squirrels and can therefore exacerbate challenges experienced by ranchers. Two Bay Area agencies require that lessees build fences around current ground squirrel colonies (interviewees). At least one prohibits filling in burrows even where they pose safety risks for sheep, cattle, and horses (interviewee). A third does not maintain specific policies on ground squirrel control, but informally asks lessees to leave ground squirrels alone due to their keystone roles (personal communication, agency manager).

Lethal control

As nongame animals with no special protection from state or federal agencies, California ground squirrels may be killed on sight. Traditional methods for lethal control include shooting squirrels, setting out poisoned bait, filling burrows, igniting combustible gas into burrows, fumigating burrows, and exploding burrows (Marsh 1998, Ford et al. 2013). These methods can be controversial because they can negatively impact non-target wildlife. For instance, poisoned bait has been found to kill non-target rodents and rabbits as well as the mammalian carnivores, scavengers, and raptors that eat the poisoned ground squirrels (Hegdal et al. 1986). Burrow destruction and fumigation can also kill the federally threatened California tiger salamander and California red-legged frog that use these burrows year-round (Ford et al. 2013).

Regardless of the method, the effects of ground squirrel control efforts are typically short-lived (Ford et al. 2013). Filling in burrows is ineffective, for instance, because ground squirrels quickly recolonize the areas where the burrows had been filled (Salmon et al. 1987). In addition, poisoning has been common for several decades, but the squirrel persists in high number (interviewee).

Managing impacts with minimal controversy

Constructing owl boxes and raptor perches to attract predators and using lead-free ammunition to shoot squirrels are lethal but wildlife-friendly alternatives to poisoning and burrow destruction (Ford et al. 2013). No formal evaluation of the effectiveness of these practices in reducing ground squirrel impacts to livestock operations was found.

Given that ground squirrel eradication is typically not a feasible goal, one grazing leasing agency is considering a program through which it would pay lessees the equivalent in forage (converted to Animal Unit Months) lost due to ground squirrel activity. In exchange, lessees must refrain from poisoning ground squirrels. The money would potentially come from mitigation fees paid by wind farms or other projects as compensation for their take of golden eagles (personal communication, agency manager).

Feral pig

The feral pig differs from the other wild animals described in this paper because it is not native

to California, and because most arguments for its protection come not from the ecological or environmental protection sectors, but instead from the hunting sector. In fact, in its informational campaign about feral pigs, the CDFW reports, "The relationship between California residents and wild pigs could be described as 'love/hate.' That is, hunters love them while everyone else seems to hate them" (CDFG 2011*a*). California, Hawaii, and Florida are the only three states in which the feral pig is a big game animal (Christie et al. 2014). Because it is not classified as a pest species as it is in other states, it has been partially protected from statewide eradication efforts (Waithman et al. 1999, Zivin et al. 2000, Christie et al. 2014). Given the agricultural and ecological damage they cause, this partial protection is controversial for entities with agricultural and conservation goals, and these constituencies are calling for an update to the CDFW's current pig policy (Barrett 1993, Seward et al. 2004, Kreith 2007, UC Statewide IPM Program 2007).

Distribution, abundance, and behavior

The feral pig is a hybrid of domesticated swine and European wild boar (Barrett and Pine 1981). It is found in at least 39 states, with the largest populations in California, Florida, Hawaii, and Texas (Seward et al. 2004). Spanish settlers first introduced domesticated swine to California in 1769 (Pine and Gerdes 1973). The European wild boar was introduced to Monterey County in 1925 (Barrett and Pine 1981). Feral pigs are found in 56 of California's 58 counties (CDFW 2014*g*) and cover at least 25% of the area of the state (Waithman et al. 1999). In 1983, the statewide population was estimated to be 80,000 (Clark et al. 1983). By 1996, this estimate exceeded 133,000, and over 80% of the population was thought to be in the North and Central Coast regions (Waithman et al. 1999). Between 1992 and 2004, their range in California expanded by 18,100 km^2 (UC Statewide IPM Program 2007).

The feral pig's success stems from its omnivorous (generalist) diet selection, strong senses of smell and hearing, ability to live in many different climates, and fecundity (Waithman et al. 2001, Seward et al. 2004). Each sow can produce two litters per year, with an average litter size of 4.5 piglets, and litters of ten are not unusual (Taylor et al. 1998, Waithman et al. 1999, 2001). They also typically increase production as mortality increases, due to increased resource availability (Baber and Coblentz 1986, Bomford and O'Brien 1995). Research on pig eradication efforts suggests that reducing or maintaining a population requires elimination of at last 70% of its individuals within one year (Saunders 1993, Waithman et al. 1999).

Feral pigs travel in groups (UC Statewide IPM Program 2007) and graze like other ungulates, but because their stomachs are simple, they do not ruminate. Instead they must graze continuously to access sufficient nutrition (Seward et al. 2004). Rooting through the soil is a primary strategy to find food. In addition, their lack of sweat glands results in their need to wallow in mud.

Impacts to livestock production

The ranchers interviewed generally said pigs were a big problem, with one succinctly saying that the wild pig "is the nemesis." By rooting, digging, trampling, wallowing, and eating, pigs damage pasture, fence, and water developments on California ranches at a cost of at least $1.7 million each year (Frederick 1998, Seward et al. 2004). Pig damage to ecosystems and

agriculture in the United States is estimated to cost $1.5 billion annually (Pimental 2007).

Pigs in California carry or have been exposed to brucellosis, pseudorabies virus, sylvatic plague, trichinellosis, and toxoplasmosis – all of which are contractible by livestock (Sweitzer et al. 1996). They shed *Cryptosporidium parvum* oocysts and *Giardia* sp. cysts, which threaten surface water safety and quality (Atwill et al. 1997). Their presence was linked to the September 2006 *E. coli* O157 contamination of spinach growing in San Benito County (Jay et al. 2007). On the whole, the literature suggested that actual cases of disease transfer from feral pigs to livestock are not prevalent, but because feral pigs remain reservoirs of disease, their persistence reduces the chances of eradicating several livestock diseases from the country (Witmer et al. 2003).

Feral pigs also indirectly impact agriculture through ecological damage. In their search for food and wallows, they destroy desirable native vegetation (Kotanen 1995, Cushman et al. 2004); consume and reduce habitat conditions for native wildlife; and increase watershed erosion and sedimentation (UC Statewide IPM Program 2007).

Pig damage is spatially heterogeneous. For instance, interviewees from the Bay Area reported that current pig management is generally effective at preventing and reducing damage in the region. One Bay Area interviewee even mentioned the "…great success trapping pigs" in the region. In contrast, producers and managers to the north and south reported more persistent difficulties.

Lethal control

The CDFW allows three methods for the take of feral pigs: killing on sight if it is encountered damaging private property, trapping if a depredation permit is acquired, and hunting (CDFG 2011*a*). Only about 40% of California's feral pig population is removed annually through these methods; considering variation between counties, most areas remove pigs at a rate significantly less than the 70% threshold required to maintain or reduce pig populations (Saunders 1993, Waithman et al. 1999).

In the late 1980s, public concerns over agricultural and ecological damage by feral pigs, catalyzed largely by the California Native Plant Society, led to legislation requiring hunters to purchase pig tags and hunting licenses (Barrett 1993, Waithman et al. 1999). The resulting policy required that hunters purchase a minimum of five tags to foster control, but currently there is no minimum (Christie et al. 2014). Pig tag sales have increased since the 1990s, with approximately 60,000 being sold each year, on average, since 2004 (CDFW 2014*g*, Christie et al. 2014). In 2010-2011, hunters reported 3574 pig takes from 42 of California's 58 counties, 93% of which were on private lands (CDFG 2011*b*). In 2002, the number was twice as high, at 7770 reported pig takes, with 94% from private lands (CDFG 2002).

Pig hunting may be contributing to the spread of pigs. Some managers of private-lands hunting programs work toward attracting pigs by planting grains (Seward et al. 2004, Macaulay et al. 2013). In addition, although it is illegal, some managers may be translocating them to establish populations (Barrett and Pine 1981, Kreith 2007).

Intensive eradication can be conducted on conservation lands if a permit agreement is established with the CDFW (Sweitzer and McCann 2007). When the National Park Service and The Nature Conservancy planned a feral pig eradication program for Santa Cruz Island in the 2000s, about sixty people met to discuss alternatives at a Channel Islands Animal Protection Association meeting in Santa Barbara (Clodfelter 2005). Editorials condemning the eradication project were published (e.g., Markarian 2005). However, the project ultimately proceeded, with 5036 pigs removed by trapping, aerial shooting, ground hunting, and dogs between 2004 and 2006 (McCann and Garcelon 2008).

Managing impacts with minimal controversy

Exclusionary fencing can keep pigs at bay, but can be prohibitively expensive. At Pinnacles National Park, in concert with its eradication program, a 26-mile exclosure fence was constructed around 14,000 acres. Construction began in 1985 and was completed in 2003 at a cost of nearly $2 million (McCann and Garcelon 2008). The cost to maintain the fence is approximately $55,000 annually (original source unknown in Kreith 2007), with much of the annual cost allocated for inspection and repair (personal communication, Pinnacles National Park staff). The fenced area is now considered pig-free (personal communication, Pinnacles National Park staff). While this strategy is considered effective for management of natural resources at the Pinnacles (personal communication, Pinnacles National Park staff), it is likely cost-prohibitive for most livestock operations.

Ranchers on privately owned land may have the opportunity to earn additional income from pig hunting (Macaulay et al. 2013). In southern Monterey County, for example, hunters pay as much as $750 for a two-day pig hunt on a private ranch (http://www.pig-hunt.com/). Sport hunting alone does not typically reduce or remove feral pigs from a landscape, so land owners and managers must weigh the costs and benefits of maintaining pig populations (Seward et al. 2004).

Wildlife biologist and feral pig expert Dr. Reginald Barrett of UC Berkeley has recommended that in order for the CDFW's management strategy to fulfill the goals of hunters as well as agricultural producers and ecologists, these tactics should be incorporated (excerpt from Barrett 1993):

> 1) removing wild pigs from parks and nature preserves to the extent feasible,
> 2) discouraging the illegal introduction of wild pigs into new habitats,
> 3) promoting the use of sport hunting to control pig numbers where they cannot be eliminated, and
> 4) encouraging monitoring and basic ecological research on wild pigs, including their effects on native ecosystems.

Successfully implementing these tactics, and indeed all of the effective, low-controversy wildlife management strategies discussed in the following concluding section, requires a strong understanding of wildlife spatial and temporal population dynamics (Waithman et al. 1999,

Seward et al. 2004). Hunting tags are helping to enhance this understanding for the feral pig: for each successful take, hunters are required to record take information on half of the tag and send that half back to the CDFW. Also, funds from tag sales are allocated toward basic research aimed at informing effective management strategies (Waithman et al. 1999).

Conclusions

Three general approaches are being used widely to manage wildlife impacts to livestock production in the California Coast Ranges. The tradition of lethal control continues, but is less controversial when it is compatible with wildlife protection goals. The nonlethal exclusion of wildlife from livestock grazing areas – using fencing, guard animals, and modified husbandry practices – is the second general approach. Lastly, monetary compensation for producers whose operations are impacted by wildlife is gaining prominence as a mitigation strategy. Managing the impacts of each of the five wildlife species described in this paper requires a unique combination of approaches.

The depredation permit is the primary management tool available to graziers to respond to livestock losses to mountain lions and to prevent future losses. The literature review and interviews conducted for this paper suggested that this tool is not highly controversial among wildlife protection groups; however, it is insufficient from the producers' perspective. Nonlethal exclusion has been effective in some settings, but not in others. Regional planning and strategic placement of livestock operations may be the most effective approach to reducing mountain lion livestock kills across the Californian range in the long term. In the meantime, some compensation is being offered for livestock death loss experienced by lessees on public lands.

For private landowners willing to focus on tule elk production, hunting programs can offer low-controversy lethal control and monetary compensation for damages to livestock operations. Where hunting is not sanctioned, such as at Point Reyes, agency employees and producers are working together to develop creative management strategies. Diligent upkeep and repair of fences was mentioned often by interviewees, but given the intensive impacts of elk to some ranches, these practices may be effective only in certain areas.

Lethal control of coyotes is less controversial when it is selective – targeted toward individual problem animals as opposed to a population at large. It turns out that selective removal also has the potential to effectively reduce livestock death loss. Nonlethal exclusion has also shown promise, but can be expensive. The Marin County Livestock Protection Program is an excellent example of a local government subsidizing nonlethal exclusion practices.

Lethal control of the California ground squirrel has become somewhat controversial because this species is increasingly considered a critical ecosystem component with keystone roles, and because lethal methods can impact non-target wildlife that depend on ground squirrels for their burrows and prey. Moreover, lethal control is largely ineffective at reducing ground squirrel numbers. The best approach to mitigating their impacts may be through monetary compensation efforts, such as compensating for forage losses caused by ground squirrels.

The feral pig, the only exotic species described in this paper, introduces a unique set of considerations. Pig damage is extensive and expensive from agricultural and ecological perspectives, yet feral pig hunting is very popular and lucrative. Within a single ranch, feral pig hunting may offer some respite from pig damage, but depending on management strategies, such programs can also result in further proliferation of pigs on the countywide or statewide scale. While a good example of pig exclusion is provided by Pinnacles National Park, such an approach could be cost-prohibitive for small grazing operations and smaller parks and preserves. It appears that the improved CDFW management strategy called for by many constituencies will require a deeper understanding of the pig's dynamics.

Differences in effective management strategies aside, all five species share two important attributes. First, all have gained the appreciation of Californians within the past century. Even the California ground squirrel, regarded as a pest for many decades, has come to be considered an ecologically important species with keystone roles. Moreover, despite its extensive agricultural and ecological damage, the non-native feral pig also has strong advocates in the hunting community. As a result, nonselective lethal wildlife control that targets entire populations instead of specific problem animals (or, in the case of the feral pig, lethal control that aims to eradicate the state's population) cannot be implemented without controversy.

A second important attribute shared by the five wildlife species – and indeed by all wildlife in the Coast Ranges – is a reliance on unpaved land. Although livestock production has altered Coast Range ecosystems in the years since it was intensified during the Gold Rush, conservationists and ranchers have come to agree that the continuation of ranching is a critical defense against commercial and residential development of the wide open spaces that keep California beautiful and ecologically vibrant. Seeking out new collaborative strategies to effectively manage wildlife impacts with minimal controversy will be an important part of keeping ranchers in business and preserving California's rangeland heritage. One rancher captured this notion well, saying, "Wildlife habitat will never be like it was before Europeans got here. We do the best we can."

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