



Figure 1. Bears in high mountain grasslands. Trinity Alps, CA. Photo courtesy the author

Game Species Management and Economics of Hunting Enterprises in California Grasslands

by Jeffery W. Stackhouse¹, Gregory A. Giusti², and Luke T. Macaulay³

Grassland as habitat for game species

California grasslands and oak savannas play an important role in providing habitat for a rich variety of plants and animals (Meyers et al. 2000). Of the myriad species that occur in California grasslands, game species are one of the most economically significant due to their value for wildlife watching and hunting. Due to economic and cultural importance, managing these species is of interest to private landowners, land trusts, and land managers, as well as local, state, and federal officials. This article provides a primer on the important game species that occur on California grasslands, and describes game management on grasslands and the economics of hunting enterprises.

Because game species often move across many vegetation types, we discuss game species that occur in three grass-dominated

vegetation types: 1) continuous grassland areas, including annual grasslands and coastal grasslands; 2) savannas, oak savannas, and mixed oak-conifer grasslands; and 3) shrublands such as sagebrush-steppe, mixed chaparral, and desert ecosystems that include interspersed grasses. We define game species as wild animals for which seasons and bag limits for hunting have been prescribed and which are harvested under state or federal laws, codes, and regulations. Game species are generally broken into categories of big game (e.g., elk, deer, pigs, bear), small game (e.g., tree squirrels, rabbits), and upland game birds (e.g., quail, pheasant, turkey). Here we focus mainly on big game, but also discuss common upland game bird hunting.

Today, approximately 50% of California is considered by the USDA to be pasture and rangeland (Agricultural Issues Center 2009). These vast areas are particularly important in their provision of food resources for game species. Grasslands provide big game, such as deer and elk, forage from grasses, forbs, and browse. Popular game bird species rely on grasslands for nesting cover, as well as grassland seeds and insects that supply nutrition for survival and growth. Grasslands are often interspersed with a mosaic of woody species that provide additional habitat resources, such as hiding cover and acorns from oaks.

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¹University of California Cooperative Extension, Humboldt-Del Norte Counties, Eureka, CA; California Certified Rangeland Manager #113.

²University of California Cooperative Extension, Lake-Mendocino Counties, Ukiah, CA; California Registered Professional Forester #2907.

³Department of Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, CA.

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Grassland management and disturbance

Grasslands across the United States have evolved with disturbance (Barry et al. 2006), and ongoing disturbance is required for the maintenance of many grassland habitats. Historically, Native Americans managed California's landscapes with fire to maintain grasslands and shrublands on the landscape for their value as food production and attractants to game animals (Anderson 2005, Barry et al. 2006, Lake 2017). Burning creates openings in brush and shrub canopies and can temporarily increase the quality of ungulate forage by removing old, decadent forage and allowing fresh regrowth of grasses and forbs the following year (Dasmann and Dasmann 1963, Longhurst et al. 1979). Early European settlers continued to use fire until the middle of the 20th century and introduced other disturbances such as livestock grazing and clear-cut forestry practices which created and maintained open grassland areas.

Today, fire has been abandoned due to liability concerns, increased regulations, a culture of fire-suppression, and air quality concerns, among other constraints (Quinn-Davidson and Varner 2012). Combined, these changes have resulted in a shift toward a more homogenous landscape with increasing shrub and conifer encroachment into grasslands. While these changes have resulted in increased woody cover, they have negatively affected game species populations such as deer and quail, which benefit nutritionally from early-seral vegetation found in recently disturbed grasslands (Higley 2002).

Management actions to enhance game species

A suite of tools is available to grassland managers to improve habitat values for a variety of game species (Table 1). In general, these tools remove old, decadent plant materials and allow new growth that can be beneficial for most game species, and will enhance hunting opportunities. Managers should consult with their local cooperative extension advisor or other natural resource managers (e.g., Natural Resources Conservation Service, United States Fish and Wildlife Service, California Department of Fish and Wildlife, California Department of Forestry and Fire Protection, or natural resources consultant) to determine the best timing and approach to meet their particular goals.

Economics of hunting

California rangelands are recognized for the economic value they provide to the ranching community via livestock production, but the value of these lands for recreation, particularly hunting recreation, is often overlooked. Recent research has found that hunters across the U.S. spend approximately \$1.5 billion annually to access private land for hunting (Macaulay 2016). In California, many landowners have built business enterprises around hunting opportunities, including opportunities to reduce nuisance species such as feral hogs (*Sus scrofa*). Returns from hunting operations vary significantly due to the wide variety of amenities, management effort, quality of hunt, and membership of hunting leases. Most landowners who incorporate

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Table 1: Management practices for enhancing game species habitat in grasslands

Practice | Impact

Fire | *Can reduce woody encroachment and reset shrub communities to an early-seral state, providing a mosaic of habitat types, and reduce undesirable, late-phenology, invasive herbaceous species (Biswell et. al. 1952, Biswell 1961).*

Grazing | *Can increase forb production in grasslands (Hayes and Holl 2003), which are a preferred forage for deer and quail.*

Leaving cover | *Mosaics of dense woody cover intermixed with herbaceous or early-seral shrubland communities are an important habitat feature for wildlife, as it provides cover from predators and refuge during extreme weather events (Dasmann 1950).*

Oak planting/maintenance | *Due to the invasion of annual plants in California grasslands, changes in grazing regimes, and altered fire regimes, many oak species in California are lacking regeneration. Any effort to increase the diversity of oak demographics to ensure their persistence on the landscape is beneficial to rangeland ecosystems and wildlife by providing acorns, cover, and a longer growing season for herbaceous plants under the oak canopy (Giusti and Schmidt 1996, Dahlgren et al. 2003).*

Forestry | *Forest managed for more open stands with herbaceous or shrubland understories can provide better habitat for game species. Thinning, burning, and mechanical treatments are commonly used to treat dense forest stands (Rochelle 1992).*

Chemical | *When weather or permitting processes limit the use of fire, chemical control can provide an excellent surrogate for treating undesirable plant species.*

Mechanical | *When fire or chemical treatments are infeasible, and where slopes permit, mechanical treatments are beneficial for resetting woody species communities to an early-seral stage.*

Predator management | *Coyotes and black bears are a significant predator of deer fawns, particularly during the first 30 days of life (Conger and Giusti 1992, Wittmer et al. 2014). Managing coyote populations to reduce fawn predation has been noted by some to be an important tool for increasing deer recruitment, while others argue that coyote control can disrupt ecosystem dynamics with little effect on the overall fitness of deer populations.*

Game management | *California land managers generally do not gather sufficient information to adequately manage deer populations. Knowledge of population parameters, including sex ratio, female survival, and fawn survival, is important for making management decisions, such as whether a population's growth rate can be increased by culling female deer that are not fawning (Macaulay 2015). There are several techniques for gathering this information for game species, including road surveys, spotlight surveys, and camera traps, as well as documenting harvest and the ages of harvested deer. Research has shown that culling female deer at Hopland Research & Extension Center enhanced buck harvest, presumably by increasing fawn survival and increasing buck-to-doe ratios (McCullough 2001).*

Game Species Management *continued*

hunting leases into their operations can achieve regular economic returns between \$1 to \$10 per acre, which can stabilize highly variable returns from the livestock industry (Macaulay 2015).

Game species of interest

Deer: The staple of California big game hunting is deer (*Odocoileus hemionus* subsp). In California, mule deer populations are split into six subspecies (Higley 2002, CDFW 2017). Each subspecies consumes mixed diets of highly digestible forbs, shrubs, and acorns, with grasses often composing less than 5% of their diet (Hoffman and Stewart 1972, Robinnette et al. 1977, Longhurst et al. 1979, Anderson and Wallmo 1984, Gogan and Barrett 1995). Although each subspecies has slightly different habitat preferences, open grasslands with water resources and some level of tree or shrub cover are important for robust deer populations.

A common misperception is that deer compete directly with cattle for forage year-round, but in fact, the competition is seasonal. Deer compete seasonally for high-quality forbs, but only in areas of high deer densities does competition negatively affect livestock production — commonly in areas of high deer densities and on inland irrigated pastures and hay fields. Another common misperception is that moderate cattle grazing is detrimental to deer populations. Does select areas of increased cover for fawning and often concentrate in riparian areas for fawning cover (Loft et al. 1984). Moderate grazing, however, can enhance deer forage by reducing grass cover, allowing greater production of highly-palatable forbs, an important component of deer diets from early spring through senescence (Gogan and Barrett 1995, Hayes and Holl 2003). Winter and early spring cattle grazing reduces grass cover and allows for legumes to establish; in fact, more stands of nitrogen-fixing legumes, like clovers, have been lost by too light of grazing than by heavy grazing (George and Clawson 1987).

Likewise, retaining oaks on rangelands for wildlife is often thought to decrease rangeland production for livestock, but a study by Dahlgren et al. (2003) showed that removal of oaks provides only short-term increases in herbaceous production, and that retention of oaks enhances soil quality, increases net productivity, and enhances overall herbaceous species diversity.

Elk: California is unique in that it has three of the four North American elk species, all of which prefer different habitat types. All three are predominantly grazers with varying levels of browsing depending on season and habitat conditions (Findholt et al. 2004). Tule elk (*Cervus canadensis nannodes*), endemic to California, once roamed the state in numbers close to half a million (McCullough 1971). They are commonly seen in blue oak (*Quercus douglasii*) and valley oak (*Q. lobata*) savanna habitats from the Pacific Coast to the Central Valley. Roosevelt elk (*C. canadensis roosevelti*), the largest-bodied of the three elk species in California, are coastal elk, and range from California's north coast to Canada. They often prefer the fog belt of the ocean during hot summer months, but also frequent Oregon white oak (*Q. garryana*) and California black oak (*Q. kelloggii*) savannas and lush coastal pastures. Rocky Mountain elk (*C. canadensis nelsoni*) were transplanted into northeastern California by the California Department of Fish & Wildlife (CDFW) as a game species for hunters. California's Rocky Mountain elk utilize rangelands, and are found in a variety of habitat types including open ponderosa pine forests, high mountain meadows, and sagebrush-steppe. Like deer, all species of elk in California seek mixed habitats of forage and cover and prefer areas with low levels of human disturbance (Huber et al. 2011).

Tortenson et al. 2002, studied elk economic impacts to cattle ranches in Montana where they found cattle herd size, gross margin, and available forage decreased significantly ($P < 0.05$) as elk numbers increased, and cattle herd size could increase 7 to

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32% with 100% removal of elk from the 5 ranches they studied. Although elk compete with cattle for forage resources and can be detrimental to ranch infrastructure, bull elk are valuable as a trophy-hunted species, which can recover some of the cost of lost forage and infrastructure damage if sufficient tags can be obtained (Torstenson et al. 2002).

Pigs: Feral hogs (*Sus scrofa*) (a.k.a wild pigs) frequently create large areas of exposed soil from rooting during forage activities on rangelands. This bare and open soil is readily available for the quick establishment of exotic or invasive species. The health of California grasslands could be greatly enhanced by reducing the size of feral pig populations (Tierney and Cushman 2006). Although opportunistic hunting alone is not likely to eliminate feral hog populations, a sustained hunting and depredation effort may deter pigs from certain areas and reduce damage to grasslands (Waithman et al. 1999). Furthermore, if ranchers and landowners can receive income from hunters for providing this service, the earnings could be used for on-ranch improvements to offset pig damage to infrastructure and rangeland health. Although feral pigs can be found in mixed habitat types, including forests, some of California’s highest pig densities are, and will likely continue to be, in the oak savanna grasslands surrounding the Central Valley (Sweitzer and Van Vuren 2002, McClure et al. 2015).

Black bear: Black bear (*Ursus americanus*), although commonly associated with forested areas, they frequently forage in oak savanna and high mountain meadow systems (Figure 1). Bears commonly grub and dig in grasslands in search of food stuffs including fungi, grasses, forbs, and large quantities of insect prey in grasslands. With the recent ban on the use of hounds in California without a coupled law allowing the use of bait, bear populations are expected to increase. Additionally, bears are significant predators of deer fawns, and likely have a negative impact on deer populations (Conger and Giusti 1992, Wittmer et al. 2014). Without the use of hounds or bait, targeting bear for economic hunting opportunities proves challenging.

Other big game: Bighorn sheep (*Ovis canadensis* spp.) and pronghorn (*Antilocapra americana*) have relatively small populations in California, yet are of significant interest as game species. Both species primarily inhabit shrubland-steppe

systems of eastern California, and for private landowners in these areas, have economic viability as a game animal. The CDFW strictly limits the number of tags available for bighorn sheep and pronghorn antelope, as their objectives are to increase population numbers. Similar to elk, the CDFW allocates tags through a random lottery where hunters pay annually for a chance to be issued a tag. If drawn, hunters can pursue the game species for which they were awarded tags. Since tags are in short supply (often once in a lifetime), many tag recipients are willing to spend extra money for private land access to ensure they harvest an animal of their desired size.

Upland game birds: Upland game birds provide excellent recreational opportunities for outdoorsmen in California. Wild turkey (*Meleagris gallopavo*), chukar (*Alectoris chukar*), dove (*Zenaida* spp.), and pheasant (*Phasianus colchicus*) are some of the state’s most popular upland bird quarry. Each of these species prefer specific habitat types (Table 2). Turkeys tend to like grasslands with suitable tree cover for roosting, and adequate tall grass or brush nearby for nesting efforts. Chukar benefit from some of the nation’s worst grassland invaders, annual brome (*Bromus* sp.), and are known for living on steep ridges with ample rock cover for escape from predators. Doves, among California’s fastest fliers, present a great challenge for hunters of all age classes and abilities. Most successful dove hunts in California grasslands

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Table 2: California grassland game animal occurrence

California grassland game animals	Habitat preference			
	Grasslands	Savannas	Shrublands	Mixed habitats
Roosevelt Elk (<i>C. canadensis roosevelti</i>)	◆	◆	◇	◆
Rocky Mt Elk (<i>C. canadensis nelsoni</i>)	◇	◆	◆	◆
Tule Elk (<i>C. canadensis nannodes</i>)	◆	◆	◇	◇
Bighorn Sheep (<i>Ovis Canadensis</i> spp.)	◇	*	◆	*
Mule Deer (<i>Odocoileus hemionus</i> spp.)	◇	◆	◇	◆
Black-tailed Deer (<i>O. hemionus columbianus</i>)	◇	◆	◆	◆
Pronghorn (<i>Antilocapra americana</i>)	◇	*	◆	◇
Wild Pig (<i>Sus scrofa</i>)	◇	◆	◆	◆
Black Bear (<i>Ursus americanus</i>)	?	◇	◆	◆
Rabbits (<i>Lagomorpha</i> spp.)	◆	◆	◆	◇
Turkey (<i>Meleagris gallopavo</i> spp.)	◇	◆	◆	◆
Sage-Grouse (<i>Centrocercus urophasianus</i>)	*	*	◆	*
Pheasant (<i>Phasianus colchicus</i>)	◇	*	◇	◇
Chukar (<i>Alectoris chukar</i>)	◆	*	◇	*
Band-tailed Pigeon (<i>Patagioenas fasciata</i>)	?	◆	◇	◆
Dove (<i>Zenaida</i> spp.)	◆	◆	◇	◆
Waterfowl (<i>Anseriformes</i> spp.)	◇	*	*	*

◆ Frequent Occurrence ◇ Moderate Occurrence ? Questionable Use Patterns * Unexpected Sighting

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are in areas with trees and available water during the early September hunt. Pheasants prefer areas adjacent to farmlands with adequate food cover and large expanses of tall grasslands for nesting cover (Stackhouse 2013). Some of California's worst weeds for farming enterprises are a welcome sight to a wild pheasant in the Central Valley.

Conclusion

California is a state of diverse habitats, expansive landscapes, and ample opportunities for outdoor enthusiasts. With a decrease in vegetation management, prescribed fire, and timber harvest in public land management, and increased human populations in the state demanding more hunting, the best opportunities for successful hunts are on private lands. Now more than ever before, hunters are paying for access to hunt private lands, and landowners across the state have opportunities to provide access

to hunters for economic benefit, although such access often comes with some management responsibilities for the landowner. California's grasslands provide some of the best hunting opportunities in the state, and properly managed livestock operations can enhance wildlife habitat and subsequent hunting opportunities. Ranching and hunting enterprises are anything but mutually exclusive. As historic ranches are asked to support additional family units (i.e. parents plus the addition of their adult children's families), hunting can be a great way to diversify a ranch business portfolio and provide additional income for another family unit on the home ranch.



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