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Case Study

Habituated, tolerant, or salt-conditioned mountain goats and human safety

Richard B. Harris, Montana Fish, Wildlife and Parks, 54502 Kerns Road, Charlo, MT 59824, USA *rharris@montana.com*
Kurt Aluzas, Mt. Baker Snoqualmie National Forest, 902 SE North Bend Way, North Bend, WA 98045, USA
Laura Balyx, University of British Columbia, Kelowna, British Columbia, V1Y 8G6, Canada
Jami Belt, Glacier National Park, West Glacier, MT 59936, USA
Joel Berger, Colorado State University, Fort Collins, CO 80521; and Wildlife Conservation Society, Bronx, NY 10460, USA
Mark Biel, Glacier National Park, Box 128, West Glacier, MT 59936, USA
Tonya Chilton-Radandt, Montana Fish, Wildlife and Parks, Libby, MT 59923, USA
Steeve D. Côté, Université Laval, Biology Department, Ste-Foy, Québec, G1V 0A6, Canada
Julie Cunningham, Montana Fish, Wildlife and Parks, Bozeman, MT 59718, USA
Adam Ford, Department of Biology, University of British Columbia, 1177 Research Road, Kelowna, British Columbia, V1Y 8G6, Canada
Patti Happe, Olympic National Park, 600 E. Park Ave., Port Angeles, WA 98362, USA
Chad P. Lehman, South Dakota Department of Game, Fish, and Parks, Custer, SD 57730, USA
Kim Poole, Aurora Wildlife Research, 1918 Shannon Point Rd., Nelson, British Columbia, V1L 6K1, Canada
Clifford G. Rice, Washington Department of Fish and Wildlife, Olympia, WA 98501, USA (retired)
Kirk Safford, British Columbia Parks, Ministry of Environment and Climate Change Strategy, Penticton, British Columbia, V2A 7C8, Canada
Wesley Sarmento, Montana Fish, Wildlife and Parks, Conrad, MT 59425, USA
Laura Wolf, Idaho Department of Fish and Game, 2885 W. Kathleen Ave., Coeur d'Alene, ID 83815, USA

Abstract: Interactions between humans and wildlife include a number of consumptive and non-consumptive forms. In some cases, the increased demand for wildlife viewing can precipitate new human–wildlife conflicts. Mountain goats (*Oreamnos americanus*; goats) are native to a number of North American mountain ranges from southeastern Alaska to southwestern Montana, USA. Goat habitat typically consists of steep terrain and cold weather habitats, which has left them particularly vulnerable to climate change. Their alpine environments also make them vulnerable to disturbance by aircraft and land-based motorized human activity. We reviewed and characterized situations in which goats in close proximity to humans on foot may become a nuisance or dangerous to people. We identify how such interactions might occur, focusing on the array of intensity observed in different settings. We summarize and evaluate interventions that have been attempted and may warrant additional research. Goats that tolerate people along hiking trails, perhaps through a habituation-like process, can typically be kept at a safe distance simply by shouting, clapping hands, or vigorous gestures. Goats that have learned to associate people with a salt reward (e.g., typically urine deposited on the ground, less frequently sweat obtained directly by licking) are more likely to be successfully hazed by tossing small stones, hitting the animal in the flank or rear. Salt-conditioned goats sometimes come within touching distance of humans; we strongly advise against prodding or poking these animals with sharp objects such as trekking poles. The recreating public that ventures into goat habitat is the ultimate source of these conflicts. Education, compliance, and possibly some infrastructure improvements can lessen the potential for conflicts and provide new and safer opportunities to view goats.

Key words: conditioning, habituation, hazing, human safety, human–wildlife conflicts, mountain goat, *Oreamnos americanus,* salt, tolerance, urine

Mountain goats (*Oreamnos americanus*; goats), the only extant member of their genus, are native to a number of North American mountain ranges from southeastern Alaska to southwestern Montana, USA. Most goat range and greatest abundance is situated in British

Columbia, Canada, but goats have also been introduced to mountain ranges south of their historic distribution. In all cases, goat habitat is characterized by steep terrain and cold weather to which they have adapted locally specific habitat use strategies but which has left them particularly vulnerable to climate change (Pettorelli et al. 2017, White et al. 2018, Sarmento et al. 2019). Their low reproductive rate renders them susceptible to overharvesting, which during the twentieth century has left legacies of depopulated ranges (Hamel et al. 2006, Rice and Gay 2010, White et al. 2021). Lack of cover in alpine environments also makes them vulnerable to disturbance by aircraft and land-based motorized human activity (Côté 1996, Côté et al. 2013, St-Louis et al. 2013).

Interactions between people and goats include a number of consumptive and non-consumptive forms. Goats are an important game species sought after by Indigenous and recreational hunters, but they are also a highlight for wildlife viewing enthusiasts. In this article, we focus on interactions when goats encounter people on foot (typically in alpine environments) and become tolerant of their presence, or become conditioned to expect human-derived salt (i.e., from urine or sweat). These human–goat interactions can have dangerous outcomes for people and can lead to diminished conservation outcomes for goat management (Landers 2017).

Although lacking the attention in the literature of carnivores such as bears (*Ursus* spp.; Morehouse and Boyce 2017, Lackey et al. 2018, Proctor et al. 2018) and wolves (*Canis lupus*; Linnell 2013), human–goat interactions can be dangerous (König et al. 2020). Recently reported human–goat interactions have included the death of a hiker at Olympic National Park (ONP; Washington, USA) in October 2010 (Tsong 2010), as well as incidents resulting in minor wounds in Montana's Glacier National Park (Chadwick 1983), northern Idaho, USA (Landers 2017), Washington's Olympic Peninsula (ONP 2012), and Alpine Lakes Wilderness (Washington, USA). Other incidents causing public alarm include goats refusing to yield, following, or attempting to charge hikers. Increasing recreational use of public lands combined with recent technological advances in lightweight gear and over-snow equipment enable more people than ever to be in close proximity to mountain goats, increasing the potential for conflict. Cumulatively, these interactions raise substantive issues about causation resulting from public behaviors that lead to human–goat conflicts as well as wildlife professionals' responsibility to consider means by which to mitigate potential danger.

To our knowledge, research on risk tolerance, conditioning to attractants, and habituation to humans on foot in mountain goats is lacking. Given the needs articulated above, we present the cumulative experiences and understanding of the authors as a set of working hypotheses. Recognizing that our data are primarily anecdotal and thus vulnerable to over-interpretation, we nonetheless feel it timely to summarize the state of knowledge and propose management interventions that can be implemented given sufficient investment of resources. In this paper we: (1) define terminology used to describe human-goat interactions, (2) present brief case studies of human–goat interactions, (3) provide a menu of potential interventions that have potential to increase human safety while allowing people the benefits of observing goats in the wild, (4) suggest a conceptual hypothesis to provide context in addressing human–goat interactions, and (5) provide best management practice recommendations to mitigate the potential for conflicts.

In arguing that goats can become tolerant of humans and become salt-conditioned under certain circumstances, we urge readers to keep context in mind. In contrast to the case studies described herein, well-established research has shown that in many natural settings goats can be extremely sensitive to motorized equipment (Foster and Rahs 1983, Penner 1988, St-Louis et al. 2013, White and Gregovich 2017) and particularly to helicopters to which they do not habituate (Côté 1996, Gordon and Wilson 2004, Goldstein et al. 2005, Côté et al. 2013).

Definitions

Following Blumstein (2016), we consider habituation "a process that leads to decreased responsiveness to a stimulus with repeated presentation and is often adaptive in that it makes it less likely that individuals will respond to harmless stimuli." Following Nisbet (2000), we use tolerance to describe the state of an animal when exposed to disturbance, manifested by ob-

servable behaviors (e.g., reduced flight initiation distance, continuation of normal activity despite close proximity to humans, absence of obvious indications of fear). The process of habituation is much more difficult to document in the field than are behaviors indicative of tolerance, which is not so much a binary category as a continuum (Bejder et al. 2009). Tolerance can come about through processes other than habituation (Samia et al. 2015), and therefore, goats we characterize as tolerant may still experience fitness costs (e.g., stress responses) from close interaction with people that are not necessarily observable. Context is important, because the term habituation can also describe the possible waning of an intended behavioral response to management actions intended to discourage a goat from unacceptable proximity to people (e.g., hazing).

We use the term salt-conditioning in the same sense that managers of bear populations use food-conditioning (i.e., the development of an expectation that a reward will follow from close association with people; McCullough 1982, Herrero 2002, Smith et al. 2005, Hopkins et al. 2010), except that we believe goats much more commonly seek mineral salts than calories. Attraction to and use of naturally occurring minerals (e.g., particularly concentrated in soils in what are termed licks) is a well-known characteristic of goat biology (Singer 1978, Ayotte et al. 2008, Poole et al. 2010, Rice 2010). Goats have also frequently been observed licking unnatural salt sources such as sweat-stained clothing, road salt and de-icing chemicals, vehicle antifreeze, and other human-made substances.

We prefer conditioning to attraction (recommended by Whittaker and Knight 1998) because it more explicitly links the behavior to the process necessary to create it. We note that popular articles frequently employ habituated when salt-conditioned is probably the more appropriate term and that biologists often assume without sufficient evidence that tolerance has resulted from a process of habituation.

We distinguish aversive conditioning (Shivik and Martin 2000, Mazur 2010; termed animal conditioning [Snijders et al. 2019]) from hazing in that the former is intended to create a long-lasting, negative association to the stimulus (i.e., hikers in this case). In contrast, hazing may or may not create a lasting association but at a minimum has the objective of temporarily displacing the animal to a greater distance from the stimulus without the expectation that it will necessarily generalize the negative experience. We assume that wild mountain goats (i.e., naïve to humans) will exhibit some measure of fear and avoidance.

For our purposes, aggressive goats are those that physically contact people or display threat postures (Geist 1964, ONP 2012), but note that the term is often used by the public, land managers, or journalists to refer to goats we would term insistent (i.e., persistently following people and resistant to hazing, but not demonstrating overt aggression). Goats use considerable agonistic behaviors when interacting with each other (Fournier and Festa-Bianchet 1995, Côté 2000), which may predispose them to aggressive behavior with any people who come to be viewed as conspecifics.

We recognize that categorizing the degree to which goats interact with people is inherently artificial and that individuals can exhibit behaviors from any of these categories at any time or place, depending on circumstances. Furthermore, each of these categories are a gross simplification, an artificial Procrustean lumping together of proclivities, and are behaviors that probably are continuous in nature; thus, we attempt in this paper to be more precise when possible.

Evidence suggests that the 2 broadly defined conditions once attained (e.g., tolerant and conditioned) often reinforce one another in a positive feedback loop. We further hypothesize that aggressive behavior can arise from at least 3 situations: (1) an animal failing to get the reward it has been accustomed to getting, (2) human behavior suggestive of agonistic goat behavior unintentionally prompting an aggressive response from the goat, and (3) a dominant member of a group asserting that dominance over people it encounters if it has learned to treat humans as it would other goats.

Case studies

We present 10 brief case studies that illustrate a range of situations with which we are familiar and that provide context for our generalization and working hypotheses (Figure 1; Table 1). All are characterized by substantial visitation by humans afoot and frequent interactions with goats, but they differ in specifics as well as interventions managers have adopted (Table 2).

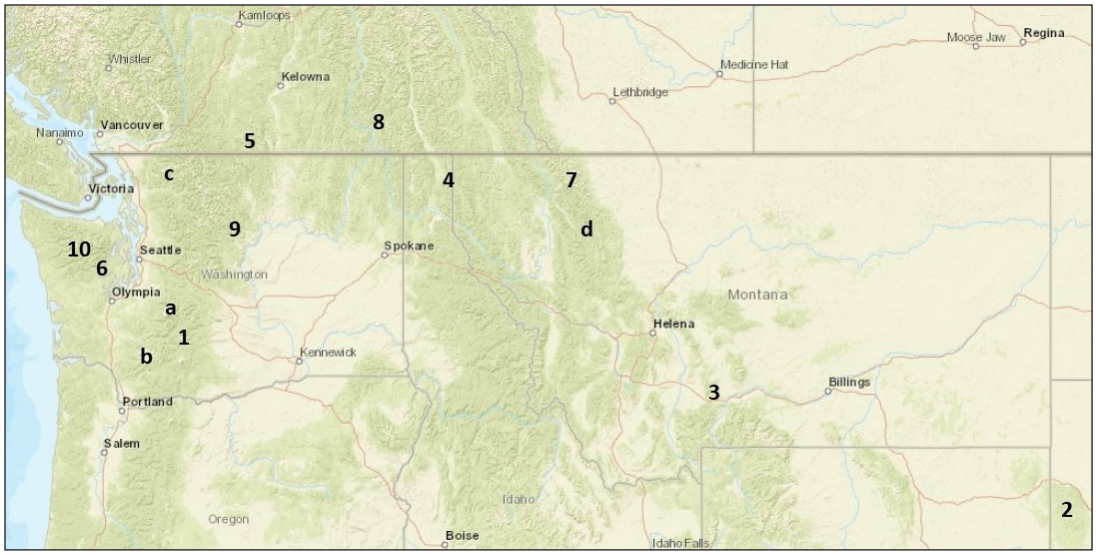

Figure 1. Northwestern United States and southwestern Canada, showing approximate locations of mountain goat (*Oreamnos americanus*) case studies mentioned in text. (1) Goat Rocks, Washington, USA; (2) Black Elk Peak, South Dakota, USA; (3) Bridger Mountains, Montana, USA; (4) Scotchman Peak, Idaho, USA; (5) Cathedral Lakes, British Colombia, Canada; (6) Mt. Ellinor, Washington; (7) Glacier National Park, Montana; (8) Gimli Ridge, British Colombia; (9) Enchantments, Washington; (10) Olympic National Park, Washington; (a) Mt. Rainier, Washington; (b) Mt. St. Helens, Washington; (c) Mt. Baker, Washington; (d) Walton Salt Lick, Montana.

Goat Rocks Wilderness Area, Washington

This portion of the Gifford Pinchot National Forest in central Washington state is locally popular for hiking, backpacking, and hunting. Accessible by vehicle with a few hours' drive from both Seattle, Washington, and Portland, Oregon, USA, some trails accessing summer goat habitat typically support >150 hikers daily, and all available camping sites surrounding the aptly named Goat Lake (abutted by goat escape terrain) are typically occupied by camping tents throughout the summer season (~ June through October). Although we are unaware of nearby mineral licks, soils tend to be highly mineralized and volcanic (Swanson and Clayton 1983). The Washington Department of Fish and Wildlife (WDFW) has generally documented 250–350 goats during aerial surveys (WDFW 2015), and a mean of 5.3 goats were legally harvested annually during 2015 to 2018 (including both state and tribal permittees (WDFW, unpublished data).

Although almost all hikers observe goats (sometimes at <100 m, more typically >100 m in distance), we are aware of no reports of goats approaching people. The WDFW has received no reports from this area through its online mountain goat incident reporting system (https://survey123.arcgis.com/share/365414ac783b454896aca2145cb7dc36). The senior author has observed foraging nanny groups for extended time periods at <50 m in distance (sometimes >100 m from escape terrain) in mid-summer, with goats neither approaching nor retreating. We consider these animals tolerant of human presence and exhibiting a habituation-like response, but they do not appear to be salt-conditioned.

Black Elk Peak, South Dakota

The Black Elk Wilderness Area is a portion of the Black Hills National Forest (South Dakota, USA) that has received high and increasing recreational use and thus increased human–goat interactions. Goats are not native to this area; the population was initiated in the 1920s when 6 goats of Alberta, Canada, origin escaped from a captive facility at nearby Custer State Park. The goat population has recently been estimated at ~135 individuals, and 2 either-sex hunting licenses are allowed annually (Lehman et al. 2020). According to Redden et al. (1982), the underlying geology in the area is primarily granitic.

Groups of nannies, kids, and billies have been observed grazing at distances of <50 m (and sometimes at <20 m) from hikers and vehicles (C. Lehman, South Dakota Game, Fish

Table 1. Summary of mountain goat (*Oreamnos americanus*) case studies reviewed. N = native goats; I = introduced goats.

Case study/ characteristic	Origin	Jurisdiction	Geology-soils	Hunted	Interactions	Interventions used
Goat Rocks	N	Washington, USA	Volcanic	Yes	Tolerant goats, no conflicts reported	None
Black Elk Peak	I	South Dakota, USA	Granitic	No	Tolerant, but aggression reported	One billy evidently deterred by medical injection
Bridger Mountains	I	Montana, USA	Low in salt	Yes	Tolerant on trails, nocturnal salt seeking	Education
Scotchman Peak	N	Idaho, USA	Sedimentary; granodioritic intrusions	Yes	Food rewards; human injury	Education, citizen ambassadors
Cathedral Provincial Park	N	British Columbia, Canada	Granitic	No	Aggressive goats in campground	Education
Mt. Ellinor	I	Washington	No natural salt licks	Yes	Salt-conditioned, insistent behavior	Trail closure, signage, intern educators, removal
Glacier National Park	N	Montana	Natural salt licks, limestone, sedimentary	No	Some salt-conditioned, others tolerant	Education, experimental staff hazing, citizen ambassadors
Valhalla Provincial Park	N	British Columbia	Igneous (gneiss)	Yes	Salt-conditioned, insistent behavior	Backcountry toilets
Enchantments	N	Washington	Granitic	No	Salt-conditioned, insistent behavior	Backcountry toilets, signage, informal stone tossing
Olympic National Park	I	Washington	No natural salt licks	No	Salt-conditioned, insistent, aggressive behavior; human fatality	Signage, staff hazing, informal stone tossing, trail closures, marking problem animals, removing aggressive animals

and Parks [SDGFP], personal communication). Most goat behavior at and around Black Elk Peak corresponds with our definition and understanding of habituation-like responses. However, aggressive encounters, albeit rare, have been reported by hikers. In July 2015, SDGFP biologists responded to an incident in which an aggressive billy frightened hikers by threat posturing and moving people off the hiking trail by approaching to within 10 m. Biologists determined that the billy had sustained a severe cut on a hind leg, which may have been

Table 2. Interventions available to managers to minimize human–mountain goat (*Oreamnos americanus*) interactions that can compromise human safety.

Intervention	Description	Advantages	Disadvantages	Case studies
Educating the public broadly	Signs at trailheads, websites, videos, brochures, newspaper articles	Low cost, broad distribution, easily coordinated	May be ineffective	All
Engaging people in the field	Citizen ambassadors, seasonal interns, permanent staff	Direct person-to-person communication	Costly, can only be implemented in limited areas	Mt. Ellinor, Scotchman Peak, Glacier National Park, Olympic National Park
Reducing availability of urine	Backcountry toilets, diluting urine	May reduce incentive for salt-seeking goats to approach people	Logistics, uncertain efficacy	Enchantments, Glacier National Park
Hazing goats	Shouting, noisemakers, rocks, paintballs, other projectiles	Low-cost, easily implemented, generally effective (short-term)	Uncertainty among public on acceptability and technique	All
Aversive conditioning	Same as hazing, but with objective of inducing long-term behavioral change of individual animals	Longer-term solutions than hazing only	Requires intensive work for uncertain outcome	Glacier National Park
Diversionary salting	Salt-blocks or similar strategically placed to divert or satiate goats seeking human salt	May reduce incentive for salt-seeking goats to approach people	Requires intensive work for uncertain outcome, health concerns for goats	Informal and poorly documented only
Identifying and removing individual problem goats	Systems to procure information from the public on particularly problematic goats, followed by either agency-implemented removal or targeted hunting	Reduces risk to humans if specific goats are the problem	Difficult to implement if in a public hunt, intensive effort if conducted by agency	Mt. Ellinor, Olympic National Park
Hunting goats generally	Agency-permitted hunts	Easily implemented within existing mgmt. structures	Unlikely to be effective	Bridger Mountains, Mt. Ellinor, Black Eagle Peak, Valhalla Provincial Park

a factor in the aggressive behavior. After being injected with an antibiotic via dart gun, the animal ran to a cliff about 300 m distant, and although later observed, has not subsequently been observed harassing hikers. Thus, it appeared that a combination of the physical injury and the subsequent medical intervention may have succeeded as hazing and may have aversively conditioned the billy. One additional aggressive incident was reported to the SDGFP between 2010 and 2021, but no additional aversive conditioning has been attempted (SDGFP, unpublished data).

Bridger Mountains, Montana

The Bridger Mountains are a heavily visited portion of the Gallatin National Forest just north of Bozeman, Montana. The goat population in the area numbers approximately 120 animals, and 5–6 hunting licenses are issued annually (Montana Fish, Wildlife and Parks [MFWP], unpublished data). In a study of mule deer (*Odocoileus hemionus*) winter range in the Bridger Mountains, Bucsis (1974) found that soils were generally low in salt content. In some portions of summer goat range, reports to state wildlife officials suggest that goats are toler-

Figure 2. Photograph that appeared on various websites of a hiker allowing a female mountain goat (*Oreamnos americanus*) to lick his leg on Scotchman Peak, near the Idaho-Montana border, USA.

ant (e.g., no response to people at <50 m at the highly trafficked Sacagawea Peak, few reports of aggressive or insistent behavior). In contrast, reports suggest that goats have adopted nocturnal movement patterns at both the Fairy Lake and Frazier Lake campgrounds (seemingly to avoid human interactions), where nanny groups have evidently attempted to procure urine near (<20 m) tents while occupants are sleeping (e.g., midnight to 0500 hours), but have not entered the campgrounds during daylight hours. In 1 case, a dog (*Canis familiaris*) accompanying a sleeping camper was gored by a goat near the tent site (MFWP, unpublished data). To date, no interventions have been attempted, but MFWP, the U.S. Forest Service (USFS), and the Rocky Mountain Goat Alliance have worked collaboratively to educate the public about recreating in goat country through signage and television news releases.

Scotchman Peak, Idaho

The Scotchman Peak trail located in the Idaho Panhandle National Forest near Sandpoint, Idaho, is a popular summer day hike in the Cabinet Mountains. Weekend trail use is ~50–100 hikers per day, most of whom encounter goats in its last kilometer where it ascends above tree line (Idaho Department of Fish and Game [IDFG], unpublished data). Geology of the area is primarily metasedimentary locally intruded by granodiorite, and diorite plutons, sills, and dikes (Earhart 1981). Aggregations of as many as 16 goats have been observed on the Peak's narrow, rocky summit in close proximity to hikers. Trail use has increased in recent years, as have reports of goats approaching hikers evidently in search of salt from backpacks and skin (Figure 2). However, instances of goats receiving human food as handouts or dropped crumbs have also been documented (IDGF, unpublished data).

In summer 2015, a hiker was injured by a goat evidently seeking salt; in response, the USFS closed the trail. In 2016, a local conservation organization called Friends of Scotchman Peaks Wilderness, together with the USFS and IDFG, created a volunteer trail ambassador program to educate hikers on appropriate behavior around goats. Volunteers have patrolled the trail on weekends and holidays from June through September and have contacted >1,000 hikers annually, encouraging them to move away from approaching goats, and if that is not sufficient to discourage the goat from approaching more closely, to hit hiking poles together or throw small stones. Educational signs providing advice on safely recreating in goat habitat have also been installed at the trailhead and along the trail. Although goats still approach hikers (some of whom allow goats to lick salt from their skin to obtain photos), most hikers try to maintain some distance, and there have not been additional human injuries reported.

Cathedral Provincial Park, British Columbia

Cathedral Provincial Park (CPP) is located on the eastern slopes of the Cascade mountain range, southwest of Keremeos, British Columbia, and just north of the U.S. border, providing hiking, camping, fishing, and mountaineering opportunities. A private lodge operates a shuttle service bringing CPP users up to the subalpine lodge, cabins, and campground facilities at approximately 2,000-m elevation. The BC Parks operates 2 campgrounds and a series of trails that access the alpine ridges within the core area of the CPP. Campground and lodge facilities are below tree line in subalpine forests (i.e., atypical summer goat habitat). Primary geology in the area is composed of exposed granitic plutons (BC Parks 1987).

Goats have long been observed along the Cathedral Rim Trail, which traverses more typical summer habitat. However, goats have increasingly begun descending to the Quinescoe and

Figure 3. Mountain goats (*Oreamnos americanus*) foraging near the summit of the Mt. Ellinor trail in western Washington state, USA (note wooden stairs), near its summit.

Lake of the Woods campgrounds, ~2–2.5 km from, and 400-m elevation below, the Rim trail. Goat use of campgrounds appears to have increased over time. Reports of goats characterized as "aggressive" began in 2017, and the park operator noted goats in campgrounds daily (~25 individuals; essentially all animals occupying the general area; BC Parks, unpublished data). In response, the park operator has informed visitors to stand aside, yielding the right-of-way along trails to goats allowing them to pass. With time, goats appeared to be spending longer periods in the campgrounds, remaining into the heat of the day in the late morning and early afternoon, when historically goats would have used snow patches on high elevation ridges.

Goats have been observed exhibiting aggressive behavior and threat displays toward each other within the campgrounds. There have been no reports of damaged gear or clothing, so attraction to sweat-stained gear appears to be less common. Anecdotes that illustrate recent interactions of concern at CPP include one in which a lodge employee stepped outside to find a mature billy standing between her and her young son. Despite the employee approaching within about 10 m to remove her son, the billy stood its ground and moved off only after the employee yelled at it (but not before giving a horn sweep threat display; BC Parks, unpublished data). Similar reports include goats that pass only a few meters from campers or refuse to cede ground to visitors or park employees. Threat display behavior toward people appears limited to a subset of the population, and only billies (perhaps just 1 individual) have been reported exhibiting behavior of concern in the campgrounds and lodge. However, reports have been received of nannies standing their ground during encounters on the alpine trails.

Goat behavior toward hikers on alpine ridges differs somewhat from that at campgrounds. Hikers encounter goats on or near the trail and regularly approach them for viewing or photo opportunities; less commonly, a close interaction is initiated by an approaching goat. Although goats in alpine areas generally appear less tolerant of human approaches than those in campgrounds, distances of <20 m in proximity are not uncommon, and threat postures and refusing to yield the trail have been documented in the alpine hiking trails (BC Parks, unpublished data).

Mt. Ellinor Trail, Washington

A heavily used trail in the Olympic National Forest offers a rapid ascent to the southernmost peak of the east Olympic mountains and almost always offered hikers opportunity to see goats (which had, decades earlier, dispersed from nearby Olympic National Park) at close range. The summit is a small area where goats had been known to approach people in search of salt. Goats were sometimes encountered directly on the trail and were reluctant to move off (Figure 3) and even traveled down to the trailhead at times, presumably in pursuit of mineral salts from urine (WDFW, unpublished data).

In summer 2012, USFS and WDFW began monitoring the area after reports of aggressive goats prompted the USFS to close the trail for the season (to considerable public dismay; Thurston Talk 2012, Washington Trails Association 2012). After the trail reopened in late 2012, USFS staff, volunteers, and the WDFW began more regular monitoring of goat interactions along the trail, and toilet facilities were installed at the trailhead. Educational patrols to encourage hikers to use noise or toss stones were focused on the heavily traveled weekend and holiday periods, with supplemental patrols in between to evaluate interactions. Regular monitoring of social media trail reports, follow-up interviews with reporting parties, and independent observations made by staff indicate that the vast majority of encounters were indicative of salt-conditioned or insistent rather than aggressive behavior. However, anecdotal surveys staff conducted of hikers returning to the trailhead indicated that only a minority

used recommended interventions when closely approached by goats; some did nothing or retreated with goats following (WDFW, unpublished data).

Aggressive behavior such as threat posturing and charges were occasionally reported, though verification often proved difficult without timely reporting, follow-up, or sufficient details to confirm the purported behavior. Nonetheless, in at least 1 instance, the behavior of a large billy refusing to back down or leave the trail led WDFW to conclude that although immediate lethal removal was unnecessary, all would ultimately be better served with this animal's removal. The WDFW had opened permit-only goat hunting that included this area, but the season did not begin until October. However, several local Indigenous tribes had hunting rights in the area, and WDFW was in contact with a tribal member who was both a game warden and skilled goat hunter. When the tribally sanctioned season opened in late summer, this individual identified and legally harvested the billy in question (WDFW, unpublished data). During 2018 to 2021, most goats on Mt. Ellinor were either translocated to interior populations in Washington or lethally removed as part of the much larger removal of goats from the Olympic Mountains (Happe et al. 2020, Harris et al. 2020).

Glacier National Park, Montana

The Hidden Lake, Highline, and Mt. Brown trails in Montana's Glacier National Park (GNP) are all heavily used trails (combined >2,000 people per day) providing access to spectacular scenery (sedimentary mudstone geology) as well as providing the opportunity to view iconic wildlife species such as bears, bighorn sheep (*Ovis canadensis*), and goats (Markegard 2014, May 2020). In addition to the 3 trails mentioned, close encounters between goats and recreationists are reported annually at the Sperry Chalet, Mt. Brown, and Lake Ellen Wilson backcountry campground. Some goats exhibit habituation-like behavior, whereas others are clearly salt-conditioned and drawn to anthropogenic salt sources (GNP, unpublished data).

Sarmento and Berger (2017) reported that goats used human salt (urine patches) for an average of 11.4 days after initial deposit at Sperry, Hidden Lake, and Highline trails, and goats at these sites did not flee from people as readily as those in more remote areas. Goats characterized as salt-conditioned spent more time away from the safety of cliffs and engaged in behaviors beyond salt acquisition (e.g., bedding and decreased vigilance). When these trails were closed during a wildfire, goats returned to the safety of cliffs despite salt still being available, suggesting that these goats may also receive protection from predators through spatial overlap with people (Sarmento and Berger 2017). These same goats exhibited reduced response to artificial (modeled) predators compared with goats in remote settings, further suggesting that human-mediated predation refuges may play a role in goat habituation and spatial overlap with people beyond mineral demands (Sarmento and Berger 2020).

In 2021, GNP staff began a program of focused hazing of goats at Mt. Brown and Logan Pass in an attempt to change the salt-driven behavior of the goats in these areas. Techniques have included yelling, clapping hands, throwing stones, launching stones with slingshots, marking goats with paintballs, and, when safe to do so, using expired bear spray to deliver a short spurt of bear spray at goats that approach too close to humans. Although flight and avoidance behavior has resulted, we do not know if these actions have been successful in aversively conditioning goats over a longer term (GNP, unpublished data).

Gimli Ridge, Valhalla Provincial Park, British Columbia

Gimli Ridge in Valhalla Provincial Park (VPP) is an increasingly popular hiking, climbing, and camping area in the Selkirk Mountains of British Columbia (southwest of Slocan Lake), accessed by a 2-hour hike at the end of a logging road. Geology of the area is considered to be primarily igneous (in particular, gneiss; Wildland Consulting 2004). Since the late 2000s, goats have frequented the campsite in increasing numbers (likely >20–25 goats currently), displaying salt-conditioned behavior toward people, and do not exhibit avoidance or flight to safety responses. During late spring through early fall, goats wander around the campsite (Figure 4) and the base of the climbing routes up Gimli Peak. After people urinate, goats lick it from rocks or eat the affected soil. Although the goats are not typically aggressive, they can be described as insistent, often approaching to within 1 m of people. Goats have also pur-

Figure 4. Mountain goats (*Oreamnos americanus*) investigating a backcountry campsite near Gimli Peak, British Columbia, Canada (*photo courtesy of K. Poole*).

sued climbers at the base of the climbs, who have increasingly expressed concerns for their safety from potentially aggressive goats as well as from rockfall resulting from goats' activity above. Goats encountered away from the campsite and climbing area exhibit more wary behavior and avoid close approaches to humans (VPP, unpublished data).

To address this problem, BC Parks installed an enclosed urine diversion toilet and 2 urinals in 2015, with the objective of reducing goat access to urine. Concurrently, BC Parks increased public education and trail signage activities. To date, however, these actions have had little evident impact on goat presence and behavior. Six goats were captured and radio-collared in June 2021 to understand movements and timing of access to the campsite, with the ultimate goal of placing diversionary salt licks distant from the campsite area in an effort to reduce human–goat interactions (BC Parks, unpublished data).

Enchantments, Washington

The Enchantments are a well-known hiking destination within the Alpine Lakes Wilderness, designated as a special use area and managed by the USFS, and is located ~ 2 hours (driving) from the Seattle area. The Enchantments consists of rocky, alpine terrain resulting from a plutonic batholith (Erikson 1977), with limited forage-producing herbaceous vegetation. Because of its popularity and to limit visitor pressure, the USFS restricts overnight use by requiring (limited) permits that are only valid during specified times (and which allow group sizes only as large as 8 persons); day use is unlimited, but pets are prohibited. The area is renowned for the ease with which hikers can observe goats at close range.

The primary through-hiking trail traverses the only available sedge-dominated foraging areas. Because camping sites sit atop or are adjacent to these sedge patches, goats and humans compete for their use. In 2018, WDFW's ground-based observations of 65 unique goats (16 of which were kids) suggested that all adult goats were conditioned to seek salt from human urine deposited on the ground, but none obtained salt directly from human sweat. When goats approached hikers at close distance, small stones tossed gently at the goats succeeded in displacing them a short distance, but they remained in relatively close proximity. No evidence suggested that goats investigated campsites, tents, or backpacks specifically for a food or salt reward. It appears that goats in this area are attracted to human-sourced salt and appear to compete with each other for access to procure salts deposited on the ground immediately following human urination (WDFW, unpublished data). This salt-conditioning has resulted in goats displaying habituation-like responses: when not actively seeking salt, they treated people either as inanimate objects, or as they would other goats. Although aggression per se has not been reported, a hiker received lacerations from being gored while he was disassembling his hiking tent at an area previously frequented by goats (R. Harris, WDFW, personal communication).

Olympic National Park, Washington

In the late 1920s, prior to the formation of Olympic National Park, 11–12 goats were introduced to the Olympic Mountains by a local hunting association. By 1983, the population had expanded throughout the range, and a range-wide survey suggested the population had exceeded 1,000 animals. No natural licks are known in the Olympic Range (National Park Service 2018). By the 1980s, human–goat encounters had become common where human use was heavy, notably in the Klahhane Ridge (KR) area (adjacent to a visitor center and parking lot, used principally by day hikers but also containing backcountry campsites). During 1981 to 1989, 511 goats were removed primarily through capture and translocation within ONP and hunting on USFS lands adjacent to ONP

(Houston et al. 1994). The goat population was reduced to approximately 300 goats throughout the 1990s and restricted principally to remote and steep terrain (Jenkins et al. 2012); no human–goat encounters were reported during this time-period.

The goat population began expanding in the early 2000s, and by 2003 goats were again frequenting a few backcountry camping areas. In 2005, 4 goats, evidently already human-tolerant and salt-conditioned, re-colonized KR. These animals regularly approached or followed people and sought places where visitors urinated on or adjacent to the trail or near campsites. Reports from 2006 involving a single billy indicated that hikers were being "corralled off the trail," or being chased by the billy in a way described as aggressive (ONP, unpublished data).

The ONP staff responded to such incidents by producing and promulgating signs and other outreach materials, hazing (primarily by park rangers), and radio-collaring a dominant nanny and the above-mentioned billy to aid in hazing. In October 2010, a male visitor was fatally gored on KR (ONP, unpublished data). The victim and 2 others had been hiking on KR when they encountered a large billy, which approached and followed them down the trail for about 1.2 km. The victim sent the other 2 people ahead of him on the trail as they attempted to leave the goat behind. One member of the group later said that she observed the victim and the goat walking side by side several hundred meters behind her. The actual attack was not witnessed, but evidence indicated that the goat gored the victim in the lower thigh or knee area and severed a major artery, causing fatal blood loss. Emergency care was hampered because the goat would not move away from the victim; only a concerted effort by several bystanders succeeded in scaring it away. Later that same day, park rangers euthanized the goat; subsequent necropsy showed no disease or other significant health issues and confirmed the goat had been in rut.

In response to the fatality, ONP staff revised the goat management plan and instituted a system for collecting and recording goat observations, hazing actions, and goat responses (see below). As the goat population continued to grow at KR and elsewhere in ONP, the park also hired and trained biologists who patrolled the KR area 7 days per week after snow melt. Their primary responsibility was to haze goats coming into close proximity to people and to educate park visitors.

Responses to selected interventions

Hazing and aversive conditioning

Glacier National Park. Biologists at GNP have developed guidelines for staff to opportunistically perform hazing when they encounter human–goat interactions that are considered unacceptable. Staff will use these guidelines in areas of known human–goat interactions (e.g., Logan Pass, Sperry Chalet, Mt. Brown). Results have been promising, with goats that see humans moving away instead of approaching (Biel 2018). Staff have observed that after being hazed, goats appear to recognize the clothing worn by the hazing individual: when an hour or so had passed after the goat had retreated to a safe distance away, goats responded to the approach of the same staff member by moving away without being hazed. In contrast, when the same staff member returned wearing different clothing, goats approached them (requiring resumption of hazing). Although anecdotal, these experiences are suggestive of some temporary learning (and adaptive response) on the part of goats (GNP, unpublished data).

Olympic National Park. Biologists at ONP began recording, categorizing, and often intervening when goats were close to park visitors in 2011 shortly after the finalizing of a goat management plan. Most data were collected in heavily visited portions of the park. We used these data to ask if these incidents displayed seasonal or long-term patterns, if interventions varied in their effectiveness in resolving the incident (as well as whether the response of the goat(s) was a function of type of incident itself), and finally, whether the relative effectiveness of the chosen intervention type was a function of season or if it changed over time.

To facilitate statistical inference, we collapsed ONP's initial 9 characterizations of human–goat incident (as assessed prior to the intervention) into 4 categories we termed "not close" (generally >100 m; $n = 9$), "close but easily deterred" ($n = 84$), "salt-conditioned" ($n = 188$), and "insistent" (clearly seeking salt and not easily deterred; $n = 66$). We collapsed ONP's initial 23 characteriza-

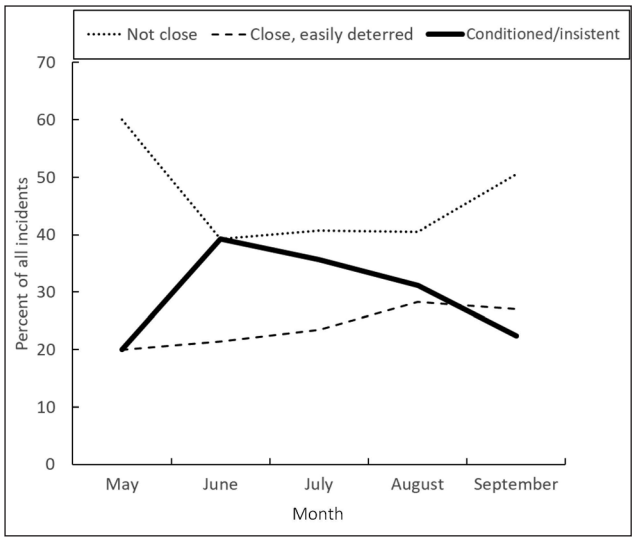

Figure 5. Percentage of all human–mountain goat (*Oreamnos americanus*) incidents in Olympic National Park, Washington, USA, 2011–2019 (*n* = 1,042) as categorized (see text), by month.

tions of intervention into 3 we termed "noise" (e.g., yelling, clapping, snapping plastic garbage bags; *n* = 124), "throwing stones" (*n* = 159), and "projectiles" (other than stones, primarily paintballs; *n* = 55). We collapsed ONP's initial 15 characterizations of goat response to the intervention into 4 we termed "moved away" (whether running or walking; *n* = 182), "moved away but stopped" (from as few as 20 m to as many as 100 m; *n* = 69), "moved away but returned" (*n* = 63), and "no response" (*n* = 33), which included the animal standing its ground and the animal continuing to approach toward the person.

Park staff documented 1,043 goat–visitor interactions during 2011 to 2019, of which 360 resulted in some type of intervention by staff. We censored 13 cases where the response was unknown, providing us with 347 from which to examine the incident type-intervention type-goat response dynamic. Because the objective of ONP staff was primarily to protect the public rather than conduct rigorous research into the efficacy of interventions, protocols did not allow for a control (i.e., observing the response of goats without intervening). Thus, these data did not allow us to infer whether interventions were more effective in resolving the situation than the alternative of doing nothing. Further, the choice of intervention was not random; interventions typically depended on the perceived intensity of the interaction, with interventions assumed to be more intrusive used when incidents appeared to involve higher risk. This lack of independence between incident and response precluded us from considering both together as interaction terms in analyses; instead, we assessed goat response to intervention category separately by each category of incident. We tested whether goat response was predicted by either incident type, or—given incident type—by the chosen intervention, using program "multinom" in package "nnet" (R version 4.0.4; R Development Core Team 2021), and report results as odds ratios relative to the reference response of "no response," interpreting effects as supported if *z* statistics yielded *P* values <0.05.

Among all reported incidents (excepting 1 anomalous report from January 2015), the percentage of incidents categorized as "salt-conditioned" or "insistent" peaked in June, gradually declining through summer into autumn (Figure 5). There was no discernible annual trend in percentages of incident type during 2011 to 2019. Across all intervention categories, the odds of the goat moving away compared with not responding were greater among animals in interactions categorized as "close but easily deterred" (odds ratio 22.7, $z = 5.29$, $P < 0.001$), but moving away was less likely than not responding among animals in interactions categorized as "conditioned" (odds ratio 0.19, $z = -2.60$, $P = 0.009$) and "insistent" (odds ratio 0.08, $z = -3.57$, $P < 0.001$; Table 3). Interventions categorized as "noise" were more likely to result in goats moving away than not responding among incidents categorized "close but easily deterred" as well as "salt-conditioned" (odds ratios 11.5, $z = 3.312$, $P < 0.001$, and 2.3, $z = 2.455$, $P = 0.014$, respectively) but were not significantly different for other incident types. However, among incidents categorized as "insistent" (*n* = 59), the odds of moving away compared with no response were greater when stones were thrown (odds ratio 8.17, $z = 1.985$, $P = 0.047$), as were the odds of moving but later returning (10.89, $z = 2.544$, $P = 0.011$). We found no support for hypotheses that the odds of moving relative to not responding varied by month or annually through time.

These analyses suggested, regardless of the

Table 3. Summary of statistically significant associations between category of human–mountain goat (*Oreamnos americanus*) interactions and goat response (moving away vs. not responding). The left 2 columns show results across all interventions; the right 3 columns show results by efficacy of interventions within each incident type. Data from Olympic National Park, Washington, USA, 2011–2019. No significant association indicated by "ns."

Independent of intervention		By type of intervention		
Incident type	Goat response		Incident type	Goat response
Close but easily deterred	Moved away>no response; $P < 0.001$	Noise	Close but easily deterred	Moved away>no response; $P < 0.001$
			Conditioned	Moved away>no response; $P < 0.001$
			Insistent	ns
Conditioned	No response>moved away; $P < 0.001$	Stones	Close but easily deterred	ns
			Conditioned	ns
			Insistent	Moved away>no response; $P = 0.047$
				Moved but returned>no response; $P = 0.011$
Insistent	No response>moved away; $P < 0.001$			

type of intervention applied, goats that are more strongly salt-conditioned (particularly to the point of being "insistent") are more difficult to haze away from people than those that may be habituated only or merely tolerant of people. When goats approach but are not insistent, a noise deterrent is likely to be successful in inducing at least a temporary and short-range successful response, but for strongly conditioned or insistent goats, stone tossing is more effective in obtaining a desired response than making noise (e.g., although the response may be temporary; we found similar responses when goats were hit with paintballs and similar projectiles but recommend their use only by agency staff, not the visiting public). Despite the expected pattern of goats' interest in salt waxing and waning seasonally, we found no evidence for seasonal differences in the effectiveness of interventions. Finally, we found no evidence that goats generally habituated to interventions (as might have been expected had efficacy decreased with time).

Hunting

Because habituated, tolerant, and salt-conditioned goats often occur in protected areas (e.g., national parks) the question arises of whether the absence of hunting may play a role in goat behavior. However, the following anecdotes suggest to us that recreational hunting—at least in intensities that Canadian and U.S. wildlife management jurisdictions currently permit in native habitats, (typically 1–4% of estimated population numbers [Hamel et al. 2006, Rice and Gay 2010])—is unlikely to reduce undesired behaviors among conditioned goats that remain post-hunt.

The USFS and WDFW continued to receive reports of insistent goats in the Mt. Ellinor area despite the initiation of a limited (permit-only) recreational hunt in the area during 2015 to 2018 that removed 13 individuals. Most of these goats were removed from near the vicinity of the interactions. In the VPP, 2 adult male goats were killed by permitted hunters over the period 2010 to 2020 during the September hunting season. Despite both removals being near the Gimli campsite where human–goat interactions have been increasing, no reduction of the insistent behavior of these goats has been observed. Both of our study areas in Montana outside of GNP where human–goat interactions have been documented (Bridgers, Montana hunting district 101, adjacent to Scotchman Peak in Idaho) have been among the more heavily hunted in recent years (Smith and DeCesare 2017). Limited, legal hunting has also occurred

in 2 areas of Washington state where goats appear to be tolerant to human presence (albeit without documented insistent or salt-seeking behavior: Mt. Baker and Goat Rocks, WDFW, unpublished data).

We speculate that the heavier hunting characterizing early eras of goat population management may have suppressed habituation, tolerance to humans, and salt-conditioning, and that much lighter hunting pressure (coinciding with heavier use of goat habitat by non-hunting hikers, but also occurring when goats' salt hunger is low) has facilitated the expression of these goat behaviors. However, available evidence suggests that hunting at sustainable levels does not by itself alleviate these human–goat conflicts (Stankowich 2008).

Physically separating problem goats from the stimulus

Managers could benefit from knowing whether tolerant or conditioned goats would retain these attributes indefinitely, or alternatively, they would revert to wild behavior in the absence of the stimulus or attraction. We generally cannot test these competing hypotheses rigorously in the wild; anecdotal evidence we have accumulated suggests to us the latter is better supported than the former. During 2018 to 2020, WDFW translocated 325 goats from the Olympic Peninsula as part of a cooperative effort to remove the species from non-historic habitat on the Olympic Peninsula while supporting struggling populations in native habitats in the Cascade mountain range (Happe et al. 2020). Responding to public concern about bringing habituated (and potentially conditioned or even dangerous) goats to new areas, we included whether or not translocated goats were considered habituated in our subsequent analyses. Because ONP staff had no way to characterize the status of each translocated goat, geography was used as a surrogate for the binary variable "habituated or not." Regions of Olympic National Park where visitors were common and where goats were known to tolerate or approach them were identified, and goats captured in these areas were considered to be habituated, whereas those captured in more remote settings were not.

Harris et al. (2019) tested for differences in short-term survival between habituated and non-habituated goats after release and found none. Further, neither WDFW, USFS, or partnering tribes received any reports that we would characterize as human–goat conflicts among released animals during 2018 to 2021. Among the 226 goats wearing global positioning system (GPS) collars, we observed no suggestions of movements toward areas where they would likely encounter humans. The heavily used Pacific Crest Trail (PCT) is located centrally to where goats were released and subsequently traveled (Harris et al. 2019), but we observed no tendency for goats to be located nearer to it than would be expected from chance alone. Mean distance from the closest point on the PCT during 2018 and 2019 was 13.3 km (SD = 11.6, n = 26,542 locations), 90% of locations were >1.6 km distant from the PCT, and slightly more than half of all locations were further from the PCT than from the goat's release site.

We examined the movements of 4 salt-conditioned goats translocated from ONP because of concern that they would be particularly susceptible to conflicts with humans due to the proximity of their initial habitat choices to human developments. In none of these cases did goats interact with humans, and in all 4 cases goats chose to leave areas near people and settle in more wild areas (Harris et al. 2019). Briefly:

1. A sub-adult nanny captured in September 2018 on KR lived a solitary existence for <1 year post-release on an isolated knob where telecommunications equipment was accessible by a forest road popular among local joggers and dog walkers (about 5 km from a state park and 7 km from 2 towns). She was photographed at least once by a local hiker (who reported no concerning behavior). In October 2019, she abruptly moved further south to slightly more remote terrain and never moved close to human habitation.

2. A large (136 kg) adult male captured in August 2019 was well-known by ONP staff. Although not considered aggressive (translocation protocols called for euthanizing rather than moving any goats identified by ONP as aggressive), ONP recommended releasing him at a remote site. Poor weather precluded using a helicopter, and thus WDFW staff released him at a road-accessible site not far from a trailhead, approximately 12 km straight-line distance from the town of Darrington, Washington. After spending approximately 1 week near

Figure 6. Young mountain goat (*Oreamnos americanus*) billy that spent a few days outside the kitchen window of a residence near North Bend, Washington, USA, and was subsequently translocated to a remote part of the Glacier Peak Wilderness in August 2019, where it stayed and was never documented near people (*photo courtesy of M. Smith, Washington Department of Fish and Wildlife*).

the release site, he traveled ~60 km straight-line distance away from the town into a remote section of the Glacier Peak Wilderness area where other translocated goats had also taken up residence. The WDFW staff received no indication that he ever encountered any humans.

3. A 3-year-old nanny (84 kg when captured at KR in September 2018) was released where public access is highly restricted (Seattle Public Utilities 2021) but shortly thereafter moved ~26 km to the only portion open to the public, a highly used recreation area where it found escape terrain on a prominent and easily accessed cliff. She quickly became the object of fascination, with flip-flop clad day-hikers and picnickers from urban areas taking selfies with her. Although no interactions were documented that suggested salt-seeking or aggressiveness, Seattle officials became sufficiently concerned about the possibility that naïve hikers would begin providing her human food, and they requested that WDFW capture and move her (Happe and Harris 2018). However, just as translocation efforts began, GPS data indicated that she had taken matters into her own hooves and begun moving back in the direction of her release site. Within a few days, she had returned to approximately her release site where we subsequently documented her traveling with other translocated goats, having no interactions with humans that we know of, and ultimately, producing at least 1 kid.

4. During the translocation project, WDFW staff received a report from a concerned citizen that an insistent goat had parked itself outside the kitchen window of her residence area near North Bend, Washington. After failed attempts to haze the animal from the residence (Figure 6), WDFW staff immobilized the young billy (which did not originate in the Olympics), kept it overnight, and added it to the already planned mixture of animals en route from ONP. It was released in a rarely hiked portion of the Glacier Peak Wilderness on August 24, 2019, quickly began traveling with another translocated billy, and has remained well within the wilderness as of this writing. Meanwhile in the Olympics, the remaining goats, even in areas where capture was focused, continued to exhibit habituation-like and human salt-conditioned behaviors up and until the last goat was removed from the area.

Working hypotheses

Because mountain goats rely primarily on retreating to escape terrain (rather than fleeing) to limit vulnerability to predation (Gross et al. 2002, Wells 2012, Sarmento and Berger 2020), they may, in some areas, tolerate humans on foot at relatively close distance and become habituated if human presence is sufficiently frequent and unaccompanied by negative reinforcement (Singer 1975). Frequent proximity and consistent reinforcement may facilitate goats learning that people can be a source of salt and ultimately come to expect that reward (i.e., become salt-conditioned). Alternatively, goats may first discover that humans can be a source of salt, initially finding ways to procure it without overcoming their natural inclination to maintain a distance that accords with their sense of safety (e.g., by entering campgrounds at night to lick urine from soil). Regardless, if goats learn that they can intimidate people by standing on a trail and not moving or closely following people until they urinate, they may develop a sense of dominance over humans and become aggressive as they might within normal mountain goat social hierarchy.

Although we lack rigorous, experimental data, we hypothesize that the likelihood of goats becoming salt-conditioned is higher where naturally occurring mineralization of soil is lacking or low. Among our case studies, those in which salt-conditioning has arguably been most pro-

nounced (ONP, Mt. Ellinor, the Enchantments, VPP) lack natural salt licks or highly mineralized soil. As in the Enchantments, Cathedral Peak is primarily granitic (and thus unlikely to produce mineralized soils), as is Black Elk Peak. In contrast, goats at heavily visited Goat Rocks, where soils are of volcanic parentage, have shown no evidence of salt-conditioning. Although not described in this paper, we know of no evidence that goats in the heavily visited areas around Washington's volcanoes Mt. Rainier, Mt. St. Helens, and Mt. Baker (Figure 1) are salt-conditioned. Goats and human visitors have relatively easy access to one another at the Walton mineral lick just south of GNP (Figure 1; Pedevillano and Wright 1987), but we are unaware of reports suggesting that goats view people as another source of salt while at the lick.

This relationship between goat behavior and edaphic characteristics (Harris et al. 2017), if confirmed by future research, should be interpreted with spatial and temporal scales in mind, as goats are known to travel considerable distances seasonally to procure minerals at natural licks (Poole et al. 2010, Rice 2010, Kroesen et al. 2020). Complicating interpretation further is the possibility that goats view proximity to people as means to reduce exposure to predators independently of their desire for salt (Berger 2007, Sarmento and Berger 2017).

Best management practices

Wildlife, land, and park managers should consider developing adequate public education, policy, infrastructure, and preventative or mitigative measures to address persistent human–goat conflicts (e.g., accessible toilet facilities even in backcountry settings, convenient toilet facilities in front country and campground areas, ensuring good access to water throughout the managed site, and constructing and managing campground perimeters in ways that excludes wildlife if feasible) well in advance of public safety issues arising. This will require forethought in planning when developing park or recreation site expansion and for specific investments to avoid expanded conflict locations as a first step. While acknowledging the need for additional research to address problem situations already occurring, we offer working recommendations for maximizing human safety while still allowing recreationalists to enjoy seeing goats. We categorize them into those intended to be adopted by the recreating public (that may, however, require that agency staff act as information messengers and compliance officers) and those intended to be adopted by land or wildlife managers.

Messaging intended for the recreating public

No feeding. In addition to the ubiquitous admonition against providing human food to any wildlife, do not let goats obtain sweat from your body, clothing, or backpacks. Always use front country and campground toilet facilities, and use backcountry toilet facilities when available. If impossible, urinate on rocks, preventing it from being absorbed into soil where it can persist. Urinating on alpine vegetation should also be avoided to prevent damage to plants from goats accessing salts. Although staying on the trail is a good general rule, find a safe place to move off-trail (30–40 m) in a rocky environment to urinate; doing so will minimize perpetuating an extensive linear salt lick. Additionally, we recommend pouring water onto urine after it has been voided (recognizing this may be logistically difficult for some hikers); anecdotal information from a heavily used backcountry campground in GNP suggests that diluting urine with water after deposition on the ground decreases the number of goats and time they spend investigating. Dilution thus offers promise of decreasing attractiveness of urine and thus human salt-conditioning of goats.

Hazing. If a goat approaches to <50 m, we recommend making noise (yelling, clapping), encouraging the goats to move off to a safe viewing distance (~100 m). If the goat resists leaving or insists on getting closer, continue to make noise, and firmly and with some energy toss small stones at the rump of the animal (not so violently as to injure the animal, and avoiding hitting the head). The stones should hit the animal (those landing nearby are unlikely to have any effect) and be about the size of a marble but smaller than a golf ball. If the goat exhibits a threat posture (horn threat), especially if it is an adult billy, back off while continuing to assert your dominance. We strongly advise against poking or prodding goats with sharp objects (e.g., trekking or ski poles). Goats are likely to interpret being poked as agonistic behavior as if from another goat and may respond in kind.

Recommendations for managers

Messaging to the public: distance. Although the heuristic message "keep a reasonable distance" is likely all that most hikers will absorb, we support consistency in messaging regarding a safe distance. Our provisional recommendation is that visitors should not approach goats closer than 50–100 m. For visitors with difficulty estimating those distances, a rule-of-thumb to consider using with visitors is that if one's thumb with arm extended is unable to fully obscure the goat, it is too close. Highly conditioned goats often approach to within much closer distances, and we doubt that hazing will often move them this far away. Thus, we acknowledge that some nuance is called for in messaging: the goal is to emphasize the danger to both humans and goats if humans encourage or tolerate close encounters or promote salt-conditioning. At the same time, neither goats nor people are served well if hikers overreact to a tolerant (or even salt-conditioned) animal exhibiting no unacceptable behavior at, for example, 50-m distance.

Messaging to the public: hazing. We acknowledge that our message to "firmly toss stones, hitting the animal" is an unusual one from wildlife managers but advocate it as an effective way to increase safety for people with minimal risk to goats (but only when animals insist on approaching very closely). Managers may also want to consider a handy slogan to remind visitors encountering goats at closer range not to use hiking poles in defense (i.e., "*Don't poke the goat*"). Where goats are highly tolerant of humans or salt-conditioned, managers should recommend against (and require leashes or prohibit where possible) dogs, who contribute urine to hiking trails and may elicit aggressive responses from goats perceiving them as predators.

Although we recognize the value of bear spray (capsicum pepper) for deterring aggressive attacks by a variety of animals including goats, we do not recommend its use by visitors for hazing goats. We suspect bear spray would succeed in moving goats away from people temporarily, although probably not succeed as a long-term aversive conditioning. However, we see downsides to recommending routine use: in many situations discussed in this paper, people are in close proximity not only with goats but with each other. Particularly given that most hikers have not experienced using bear spray in the wild, there is a good chance that other hikers could inadvertently be exposed (and even if not directly, could come into contact with residual spray). As well, bear spray may send a message that the offending goat is in attack mode rather than in salt-seeking mode and thus alarm hikers more than is necessary. Whereas stones tossed at a charging grizzly bear (*Ursus arctos horribilis*) are unlikely to change its behavior, our experience has been that stones can keep goats at a respectable distance from people. We thus favor tossing small stones over bear spray to keep insistent goats at bay except when deployed by trained staff or if injury to a visitor is imminent.

Sanitary facilities. Where recreational use is relatively heavy, it may be difficult to prevent conditioning of goats seeking salt indirectly (e.g., from areas on the ground where humans have urinated). Toilet facilities at the trailhead may reduce mineral attractants within some distance of the trailhead, although they can be costly to install and maintain. Backcountry toilet facilities may help, although we acknowledge the significant logistical challenges with building and maintaining remote toilets.

Obtaining information from the public. We have had some success identifying potentially problematic individual animals using online reporting systems to provide an early warning system of particularly dangerous goats (e.g., https://wdfw.wa.gov/species-habitats/species/oreamnos-americanus#conflict) or emerging situations that managers may not be aware of. Social media sites that provide trip reports for hiking trails can provide useful (if subjective) accounts of encounters that can also serve to alert managers or to corroborate other reports from the same area. Citizen ambassadors and interns can be invaluable assistants in messaging. Numerous citizen science initiatives focused on mountain goats already exist, and interest in this area is growing. High compliance from the public will play a critical role in the success of any chosen intervention; compliance is likely to be higher where onsite staff, or trained interns or volunteers, can monitor and encourage recommended behaviors.

Diverting goats. Acknowledging that it would not address the factors causing salt-conditioning, diverting (and possibly satiating) goats with artificially placed salt remains an untested method that may have promise in reducing as-

sociations of humans with salt in areas of high human occupancy where compatible with land management agency policy. If salt blocks are used, they should be spaced so as to allow multiple goats simultaneous use; if loose salt, it should be dug into the soil to mimic a natural lick. In either case, salt would be placed near where goats are already congregating (close to escape terrain, but some distance from human presence). However, such actions may exacerbate alteration of natural habitat use and predator avoidance, changes in congregation patterns (which can lead to increased disease risk), as well as the possibility of creating an attraction for humans wishing to observe goats at close range. Salt blocks may increase the likelihood of pathogen transmission (e.g., contagious ecthyma) because their coarse surface may abrade goats' oral tissue. Thus, we advocate targeted research to assess whether any benefits arising from this intervention would outweigh the costs to goats, to surrounding resources, and in strictly monetary terms (see also Garshelis et al. 2017 in the context of human–bear conflicts).

Hunting. Available evidence suggests that human–goat interactions and salt-conditioning do not decrease in the presence of modest hunting off-take. Although it is possible that heavier hunting could reduce these behaviors, we suspect it would require unsustainable off-take levels to achieve, and thus this intervention would fail to meet our objectives of coexistence. However, although we do not recommend increasing hunting generally as a conflict-reduction strategy, there may be times when specific individuals should be removed, either by hunters under direction from agencies, or agencies themselves, to further the objective of coexistence.

Translocation. Although unlikely to be a first option due to its expense and intrusiveness, long-distance translocation of conditioned goats may be an alternative where other interventions fail or are otherwise contraindicated. Recent experience in Washington state suggests that animals accustomed to seeking salt from humans have not actively sought out people after being relocated to wilderness settings.

Conclusions

Mountain goats are among the most fascinating and engaging wildlife that visitors to alpine habitats can encounter, and observations typically rank among the highlights of their trips. Goats that are tolerant of humans, and thus allow observation at a respectful distance without fleeing, probably rank low on managers' list of concerns. But both goats and people stand to lose by policies (or lack thereof) that allow goats to view people as sources of salt or as 2-legged members of goat society. Simply advocating that people avoid visiting all goat habitat is unrealistic (and, in our view, unnecessary). Similarly, goats have very limited options for fulfilling their life-requisites, so they cannot be expected to vacate entirely areas where people wish to spend time. Our observations and experiences suggest that a détente is possible through active management of attractants, judicious hazing, visitor education and messaging, and possibly diverting goats that have strong salt-conditioned behaviors.

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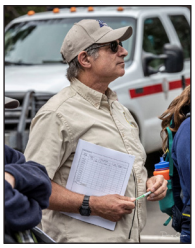
Associate Editor: S. Nicole Frey

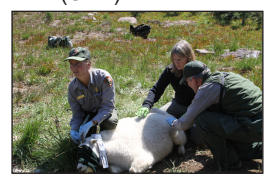
Richard B. Harris is retired from Montana Fish, Wildlife and Parks, where he coordinated the development of a management plan for grizzly bears. During 2012 to 2019, he was statewide manager for bighorn sheep, mountain goats, and moose at the Washington Department of Fish and Wildlife. He was an independent consultant on mountain ungulates in Asia, leading surveys of argali, blue sheep, and ibex in western China, Mongolia, Kyrgyzstan, and Afghanistan. He also studied Tibetan foxes and pastoralist-grassland dynamics. He served for 10 years as deputy chair and Red List coordinator for the Caprinae Specialist Group of the IUCN Species Survival Commission. He has M.S. and Ph.D. degrees from the University of Montana.



Kurt Aluzas works on a variety of land management issues and projects on the Snoqualmie and Skykomish Ranger Districts of the Mt. Baker-Snoqualmie National Forest in western Washington. His primary focus is on analyzing and mitigating the impacts of land management activities on a wide array of special status wildlife species, from northern spotted owls and marbled murrelets to bumblebees, bats, and big game species. He works with a variety of state, federal, tribal, and NGO biologists on species conservation, habitat improvement projects, and human–wildlife interactions. He formerly worked on the Olympic National Forest, where he was heavily involved with managing human–mountain goat interactions.

Laura Balyx is a recent Master of Science graduate from the University of British Columbia Okanagan, where she studied the seasonal movement and habitat use of mountain goats in Cathedral Provincial Park, British Columbia, Canada. She now works with multiple organizations on a variety of wildlife research projects, including habitat selection analysis of mountain goats, bighorn sheep, and white-tailed deer, and she is involved with research on chronic wasting disease. She is excited to continue to collaborate with numerous agencies and build her career in wildlife management.

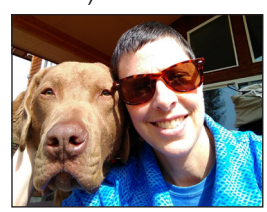
Jami Belt (left) is a biologist at Glacier National Park (USA). She coordinates public engagement-based research on numerous birds and mammals including mountain goats, raptors, pikas, and common loons. She attained her M.S. degree in wildlife biology from the University of Montana.



Joel Berger is a wildlife ecologist and works with mountain ungulates in extreme environments around the world. He is on the Colorado State University faculty and a senior scientist for the Wildlife Conservation Society.

Mark Biel oversees the Natural Resources Program and is the ungulate biologist for Glacier National Park (USA). He works with state, federal, and tribal biologists, academic researchers and graduate students, and numerous NGOs on ungulate-related research projects to provide park managers with the best available science to make informed management decisions for the park. His research focuses on habitat selection, climate change impacts, and population dynamics for ungulates ranging from moose and elk to bighorn sheep and mountain goats.

Tonya Chilton-Radandt (with her dog, Winston) is an area wildlife biologist for Montana Fish, Wildlife and Parks (MFWP). She began her work for MFWP in September 1999. She manages game species in the northwest corner of Montana. Her focal species include black bears, white-tailed deer, moose, mountain goats, elk, mountain lions, bighorn sheep, and wolves. Her work involves population monitoring and surveys for each species, setting hunting regulations, addressing human–wildlife conflicts, managing 2 Wildlife Management Areas, and assisting with research projects, habitat, disease, and other management needs. She feels fortunate to collaborate with numerous agency biologists, universities, private landowners, and NGOs.



Authors continued on next page...

Steeve D. Côté holds a Ph.D. degree from Sherbrooke University (Canada) and has conducted post-doctoral research in France, Antarctica, Scotland, and Norway. Since 2001, he has been a professor at the Department of Biology of Laval University in Quebec City, senior scientist at the Centre for Northern Studies, director of Caribou Ungava, and holder of an NSERC industrial Chair. His research focuses on the ecology and behavior of large mammals, mainly migratory caribou in northern Quebec, long-term studies on life-history strategies of mountain goats in Alberta, white-tailed deer forest relationships on Anticosti Island, and more recently, eastern moose-winter tick interactions. An important goal of his work is to produce knowledge useful for the management and conservation of populations of large mammals inhabiting boreal and arctic ecosystems.

Julie Cunningham manages all game species for Montana Fish, Wildlife and Parks within about 2 million acres (>800,000 ha) of public and private lands northwest of Yellowstone National Park. Her focal species include mountain goats, bighorn sheep, elk, pronghorn, mule deer, white-tailed deer, moose, and bison. Her work involves population monitoring and surveys for each species, setting hunting regulations, addressing conflicts, and assisting with research projects, habitat, and other management needs. Her work involves collaboration with numerous agency biologists, universities, private landowners, and NGOs.

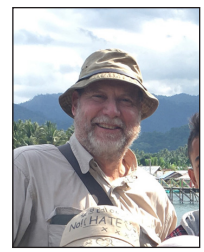
Adam Ford holds a Ph.D. degree from the University of British Columbia (UBC) and is currently an associate professor and the Canadian Research Chair in Wildlife Restoration Ecology at UBC-Okanagan in Kelowna. His research group, the Wildlife Restoration Ecology Lab, works to restore important relationships in nature's food webs, including those between people and wildlife. Some of his group's research includes studies involving mule deer, caribou, moose, Roosevelt elk, mountain goats, bighorn sheep, bison, cougars, boreal caribou, and wolves, as well as studies on bear and human interactions, chronic wasting disease modelling, and policy analysis and numerous other studies with the Provincial government.

Patti Happe is the wildlife branch chief at Olympic National Park. She was co-lead of the implementation of the Olympic Mountain Goat Management Plan. She has also worked extensively with Roosevelt elk, fishers, and Olympic marmots. Her degrees include a bachelor's degree in environment resource management from Penn State University as well as a master's degree in wildlife ecology and a Ph.D. degree in rangeland ecology from Oregon State University.

Chad P. Lehman is a senior wildlife biologist for South Dakota Department of Game, Fish, and Parks. He provides research information in a format for the management and sound stewardship of wildlife resources for the state of South Dakota. His research focuses on resource selection and vital rate dynamics related to large mammal, bobcat, and wild turkey conservation.

Kim Poole is an independent wildlife biologist with 40 years of experience in public and private sectors throughout western and northern Canada. He has worked on a host of wildlife species and has been involved in research and management on mountain goats for 25 years. Goat projects have included examining mineral lick use and winter habitat selection, numerous surveys for abundance, and projects to divert goats from high-risk areas along highways and near humans.

Clifford G. Rice, although a U.S. citizen, was born in Madhya Pradesh (M.P.), India, and his interest in wildlife grew out of childhood experiences in Madhya Pradesh, Uttaranchal, and Punjab. In addition to his doctoral research on Nilgiri tahr, he was a Peace Corps volunteer in Nepal, coordinated research on sloth bear (back in M.P.), and has been a biologist for the Commonwealth of the Northern Mariana Islands. He has retired from the Washington Department of Fish and Wildlife, where he conducted research on mountain goats and black-tailed deer in Washington state, USA. He is also on the board of directors of the Alliance for Tompotika Conservation.



Kirk Safford has been working as a professional biologist for >20 years and is currently with the British Columbia Parks-Conservation Program in the Okanagan section, where he works in >80 provincial Parks and Protected Areas. For the last 11 years, he has developed the conservation program is his region, working on species and ecosystems at risk, invasive species management, impact assessment, ecosystem restoration, inventory, and conservation research within these Parks and Protected Areas.

Authors continued on next page...

Wesley Sarmento is a wildlife management specialist for Montana, Fish, Wildlife and Parks.

His current role focuses on reducing grizzly bear conflicts with agricultural constituents on the Rocky Mountain Front. Previously, he conducted research in Glacier National Park on the direct and indirect impacts of people on mountain goats, including habituation and climate change.

Laura Wolf manages game species and big game habitat across the Panhandle of Idaho. Her

focal species include, elk, white-tailed deer, moose, mountain goats, black bears, mountain lions, and wolves. Her work involves population monitoring and surveys for each species, setting hunting regulations, and assisting with research projects. Her habitat work involves collaboration with state and federal land management agencies. She led the statewide team updating the Idaho Mountain Goat Management Plan.