Terrestrial Mammal Conservation

Global evidence for the effects of interventions for terrestrial mammals excluding bats and primates

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Cover image: Cape mountain zebra (*Equus zebra zebra*), De Hoop Nature Reserve, South Africa. Photograph by Rebecca K. Smith, CC-BY.

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7. Threat: Human intrusions and disturbance

Background

In addition to large-scale disturbances from activities such as agriculture, building developments, energy production and biological resource use, disturbance of mammal populations can come from smaller scale human intrusions. This chapter also includes some interventions aimed at reducing human-wildlife conflict where wild terrestrial mammals and humans come into contact. Such interventions, if effective, may reduce motivations or justifications for carrying out lethal control of mammals.

7.1. Use signs or access restrictions to reduce disturbance to mammals

https://www.conservationevidence.com/actions/2325

- **One study** evaluated the effects of using signs or access restrictions to reduce disturbance to mammals. This study was in the USA[1].

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

- **Use (1 study):** A replicated, paired sites, site comparison study in the USA[1] found that removing or closing roads increased use of those areas by black bears.

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Background

Access to areas by people can cause disturbance to some mammals. This may cause them to alter behaviour, including through reducing their use of such areas. To limit this disturbance, access may be restricted, including through using signage or physical barriers.

See also: *Exclude or limit number of visitors to reserves or protected areas*.

A replicated, paired sites, site comparison study in 2006–2009 of a forest in Idaho, USA (1) found that removing or closing roads increased use of those areas by black bears *Ursus americanus*. More bears were detected on former roads that had been removed (4.6 detections/100 camera-trap days) than on paired open roads (0.3). Similarly, there were more on closed than on paired open roads when roads were closed by a barrier (closed: 1.5; open: 0.6 detections/100 camera-trap days) or by a gate (closed: 0.5; open: 0 detections/100 camera-trap days). Eighteen closed roads were paired with open roads. Closed roads included seven removed by reprofiling in the previous 10 years, five closed by barriers and six that were gated. Closed roads were sampled by camera-trapping 1.6 km along from their intersection with the paired open road. Open roads were sampled <100 m along from this intersection. One camera trap was used at each site between 1 April and 30 June and again between 30 August and 3 November, annually in 2006–2009.

(1) Switalski T.A. & Nelson C.R. (2011) Efficacy of road removal for restoring wildlife habitat: Black bear in the Northern Rocky Mountains, USA. *Biological Conservation*, 144, 2666–2673, https://doi.org/10.1016/j.biocon.2011.07.026

7.2. Set minimum distances for approaching mammals

https://www.conservationevidence.com/actions/2327

- We found no studies that evaluated the effects on mammals of setting a minimum permitted distance to which they can be approached.

'We found no studies' means that we have not yet found any studies that have directly evaluated this intervention during our systematic journal and report searches. Therefore, we have no evidence to indicate whether or not the intervention has any desirable or harmful effects.

Background

At some sites, such as at national parks where safaris are a popular means of visitors observing animals, large numbers of people or vehicles closely approaching mammals may cause them disturbance or cause changes in their behaviour. This may restrict areas that these animals use or affect hunting or feeding opportunities. Limits, including through voluntary guidelines, exist in some areas on the minimum distance to which people or vessels may approach sea mammals (e.g. Inman *et al*. 2016). Similar regulation or guidelines may also lessen such potential impacts for mammals.

Inman A., Brooker E., Dolman S., McCann R., Wilson A.M.W. (2016) The use of marine wildlife-watching codes and their role in managing activities within marine protected areas in Scotland. *Ocean & Coastal Management*, 132, 132–142, https://doi.org/10.1016/j.ocecoaman.2016.08.005

7.3. Set maximum number of people/vehicles approaching mammals

https://www.conservationevidence.com/actions/2328

- We found no studies that evaluated the effects on mammals of setting a maximum to the number of people or vehicles permitted to approach mammals.

'We found no studies' means that we have not yet found any studies that have directly evaluated this intervention during our systematic journal and report searches. Therefore, we have no evidence to indicate whether or not the intervention has any desirable or harmful effects.

Background

At some sites, such as at national parks where safaris are a popular means of visitors observing animals, large numbers of people or vehicles approaching mammals may cause them disturbance or cause changes in their behaviour. This may restrict areas that these animals use or affect hunting or feeding opportunities. Setting limits on the numbers of people or vehicles permitted to be in close proximity to such animals may lessen such potential impacts.

7.4. Exclude or limit number of visitors to reserves or protected areas

https://www.conservationevidence.com/actions/2330

- **Five studies** evaluated the effects on mammals of excluding or limiting the number of visitors to reserves or protected areas. Three studies were in the USA[1,2,3], one was in Ecuador[4] and one was in Thailand[5].

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

- **Abundance (1 study):** A site comparison study in Ecuador[4] found that a road with restricted access had a higher population of medium-sized and large mammals compared to a road with unrestricted access.
- **Survival (1 study):** A before-and-after study in the USA[1] found that temporarily restricting visitor access resulted in fewer bears being killed to protect humans.

BEHAVIOUR (3 STUDIES)

- **Use (3 studies):** Three studies (one a before-and-after study), in the USA[2,3] and Thailand[5], found that restricting human access to protected areas resulted in increased use of these areas by grizzly bears[2,3] and leopards[5].

Background

Protected areas are often popular with visitors as they may contain extensive areas suited for outdoor recreation. However, high visitor numbers can damage features that reserves and protected areas are established to protect. Some mammals are shy and are thus deterred by visitors whilst others, such as bears, may come into conflict with human visitors. A policy of excluding, restricting or otherwise limiting human visitors may be put in place to reduce the potential impact of such access on wildlife, including mammals.

A before-and-after study in 1968–1972 in Montana, USA (1) found that temporarily restricting visitor access, along with translocation, awareness raising and enforcement of regulations, resulted in fewer bears being killed to protect humans. After restricting visitor access, the rate of bear killings (1/year) was lower than in the preceding 13 years, when there were no visitor restrictions (1.5/year). Following implementation of visitor restrictions, three bears were also translocated away for visitor safety reasons. In 1968–1972 visitor restrictions, such as temporary trail closures or campsite closures, were imposed following verified reports of human-bear encounters. Numbers of bears killed following restrictions was compared to that prior to implementation of restrictions. The programmme also included awareness raising and policing of adherence to local regulations.

A study in 1984–1988 in a meadow and forest area in Wyoming, USA (2) found that restricting human access resulted in greater use of areas by grizzly bears *Ursus arctos*. Bears were found further from cover during closed and restricted periods (average 293–304 m) than during open periods (average 228 m). Bears were recorded close to campsites more frequently when the campsites were not in use than when they were in use, when sightings were reduced by 67%. Within a 4,850-ha study area, containing 14–23 grizzly bears, meadows and open areas were scanned regularly from a vantage point, for bear and human activity, from May–June through to July–September of 1984–1988. At different periods during this time, the area was classed as open (allowing day-use and overnight camping), restricted (allowing day-use only, but no overnight camping) or closed (no recreational use).

A study in 2006–2009 in temperate forest in a national park in Wyoming, USA (3) found that restricting human access allowed increased use by grizzly bears *Ursus arctos*. When human access was restricted more bears used human recreation areas (9.4–10.8% of satellite collar locations) than when human access was unrestricted (4.4–9.1% of satellite collar locations). During restricted periods, human use was lower (5 recreational users/day) than during unrestricted periods (147 recreational users/day). Human and bear activity was monitored across 81,176 ha, in April–September of 2006–2009. Human recreational areas were areas that humans used more than random areas and covered 7.7% of the study area. Peak human activity times were 08.00–18.59 hrs, during which ≥10% of groups were active. Recreational access was prohibited other than on a small number of backcountry campsites and trails during low tourist season (15 April–30 June) but was unrestricted in peak season (1 July–30 September). Fourteen bears were monitored using satellite collars and 385 recreational groups, totalling 1,341 people, carried GPS loggers while using the area.

A site comparison study in 2005–2006 of forest at three sites in Ecuador (4) found that a road with restricted access had a higher population of medium-sized and large mammals relative to a road with unrestricted access. Differences between sites were not tested for statistical significance. Primates, ungulates and large rodents were more abundant along the restricted access road (98 animals/km^2) than they were along the unrestricted access road (48 animals/km^2). However, there were more still at an undisturbed site (233 animals/km^2). A 142-km-long oil exploration road was constructed in 1992. Road access for outsiders was restricted (details not provided), though the area was occupied by indigenous Waorani people, who settled and hunted along the road. At a different site, an oil exploration road, constructed in 1972, attracted colonists, leading to 4% annual forest loss in its vicinity. A third, undisturbed site was studied. Sites were ≤89 km apart. Mammals >1 kg were surveyed using distance sampling techniques along six 2-km transects at each site, in the morning and evening on eight occasions from April 2005 to July 2006.

A before-and-after study in 2003–2004 of a forest national park in Thailand (5) found that closing the park to visitors resulted in leopards *Panthera pardus* using larger areas of the park. At least six leopards

were recorded and the density did not differ between when the park was closed or open to visitors. However, leopards occurred in more locations during the closed period (22 camera-trap locations) than in the open period (13 camera-trap locations). Additionally, there was a 45% higher daily detection rate during the closed than during the open period. Human presence was lower during the closed period (nine photos) than the open period (68 photos). Following flooding in October 2003, the park was closed to visitors. Camera traps were placed for three weeks at each of 72 locations, which were approximately 2 km apart, between November 2003 and January 2004. Previously, the same monitoring strategy had been implemented during March–May 2003, when the park was open to visitors.

(1) Martinka C. J. (1974) Preserving the natural status of grizzlies in Glacier National Park. *Wildlife Society Bulletin*, 2, 13–17.

(2) Gunther K.A. (1990) Visitor impact on grizzly bear activity in Pelican Valley, Yellowstone National Park. *Bears: Their Biology and Management*, *Eighth International Conference on Bear Research and Management, Victoria, British Columbia, Canada,* 8, 73–78.

(3) Coleman T.H., Schwartz C.C., Gunther K.A. & Creel S. (2013) Grizzly bear and human interaction in Yellowstone National Park: an evaluation of bear management areas. *The Journal of Wildlife Management*, 77, 1311–1320, https://doi.org/10.1002/jwmg.602

(4) Suárez E., Zapata-Ríos G., Utreras V., Strindberg S. & Vargas J. (2013) Controlling access to oil roads protects forest cover, but not wildlife communities: a case study from the rainforest of Yasuní Biosphere Reserve (Ecuador). *Animal Conservation*, 16, 265–274, https://doi.org/10.1111/j.1469-1795.2012.00592.x

(5) Ngoprasert D., Lynam A.J. & Gale G.A. (2017) Effects of temporary closure of a national park on leopard movement and behaviour in tropical Asia. *Mammalian Biology*, 82, 65–73, https://doi.org/10.1016/j.mambio.2016.11.004

7.5. Provide paths to limit extent of disturbance to mammals

https://www.conservationevidence.com/actions/2337

- We found no studies that evaluated the effects on mammals of providing paths to limit the extent of disturbance to mammals.

'We found no studies' means that we have not yet found any studies that have directly evaluated this intervention during our systematic journal and report searches. Therefore, we have no evidence to indicate whether or not the intervention has any desirable or harmful effects.

Background

In open habitats that are popular with human visitors for recreation, providing paths for people to use may reduce the overall area of ground on which mammals are vulnerable to human disturbance.

7.6. Use voluntary agreements with locals to reduce disturbance

https://www.conservationevidence.com/actions/2339

- We found no studies that evaluated the effects on mammals of using voluntary agreements with locals to reduce disturbance.

'We found no studies' means that we have not yet found any studies that have directly evaluated this intervention during our systematic journal and report searches. Therefore, we have no evidence to indicate whether or not the intervention has any desirable or harmful effects.

Background

Human access can be a major cause of disturbance to wild mammals. In some cases, disturbance can be reduced by restricting access using regulations or laws. In other instances, local communities may have long-standing access rights or traditions and voluntary agreements drawn up in consultation with such stakeholders may be attempted.

See also: *Agriculture and aquaculture — Relocate local pastoralist communities to reduce human-wildlife conflict*.

7.7. Habituate mammals to visitors

https://www.conservationevidence.com/actions/2340

- **One study** evaluated the effects of habituating mammals to visitors. This study was in the USA[1].

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

- **Human-wildlife conflict (1 study):** A study in the USA[1] found that brown bears that were highly habituated to humans showed less aggression towards human visitors than did non-habituated bears.

Background

Some mammals can show aggressive behaviour towards humans. This can be a problem especially where the species is one in high demand from humans for opportunities to watch them, and one that is capable of causing serious injury or death to humans if it does attack. This is most likely to involve large charismatic carnivores. Where animals are predictable in their movements, there may be opportunities for habituating them to humans, thus reducing the risk to visitors. This may also, then, reduce instances in which there are pressures on wildlife managers to carry out lethal control of animals that show aggressive behaviours.

A study in 1973–1993 in a riverine and grassland site in Alaska, USA (1) found that brown bears *Ursus arctos* that were highly habituated to humans showed less aggression towards human visitors than did non-habituated bears. Results were not tested for statistical significance. No intense charges were made at people by highly habituated bears compared to eight by bears that were not highly habituated (four by 'wary' and four by 'partially habituated' bears). No human injuries

from bears were recorded. All charges, other aggressive displays and bear visits to the campsite were averted by actions such as loud noises or, occasionally, use of non-lethal rubber shot. The programme operated in a 999-km^2 protected area in which bear hunting was prohibited. Bears were habituated by being in proximity to people in non-threatening interactions (see paper for details; numbers of bears not provided). Human visitors away from the campground were restricted to 10/day, usually from early June to late August. Visitors were in groups, escorted by park staff and were instructed in exhibiting non-threatening behaviour, such as avoiding loud noises or sudden movements.

(1) Aumiller L.D. & Matt C.A. (1994) Management of McNeil River State Game Sanctuary for viewing of brown bears. *Bears: Their Biology and Management*, 9, 51–61.

7.8. Translocate mammals that have habituated to humans (e.g. bears)

https://www.conservationevidence.com/actions/2341

- **Two studies** evaluated the effects of translocating mammals that have habituated to humans. One study was in the USA[1] and one was in the USA and Canada[2].

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

- **Human-wildlife conflict (2 studies):** A study in the USA[1] found that almost half of the translocated 'nuisance' black bears returned to their capture locations. A review of studies in the USA and Canada[2] found that black bears translocated away from sites of conflict with humans were less likely to return to their capture site if translocated as younger bears, over greater distances, or across geographic barriers.

Background

Some animals, such as bears, may exhibit 'nuisance behaviour' that may bring them into conflict with humans. For example, animals may attempt to raid foodstuffs at campgrounds and such individuals may then be perceived as representing a threat to humans. Animals may be translocated away from sites where issues arise, as an alternative to lethal control. Such translocations are deemed to be successful if the animal survives and resumes natural behaviour at the release site, does not return to the capture site and does not exhibit 'nuisance behaviour' elsewhere.

See also: *Residential and Commercial Development — Translocate problem mammals away from residential areas (e.g. habituated bears) to reduce human-wildlife conflict* for situations where habituated animals are removed from established settlements rather than recreation areas. Also see *Use non-lethal methods to deter carnivores from attacking humans*.

A study in 1967–1974 in forest and grassland in a national park straddling Tennessee and North Carolina, USA (1) found that after initial translocation, almost half of the 'nuisance' black bears *Ursus americanus* returned to their capture locations. Of 76 translocated bears, 36 were subsequently caught or seen within ≤8 km of their original capture location at least once (all except two of these were ≤2 km from their capture location). In a 2,072-km^2 national park with high recreational use, bears were translocated if they exhibited nuisance behaviour (such as accessing human food). Seventy-six bears (66 male, 10 female) were moved a total of 155 times (1–13 times/bear). Bears were released 6–65 km from capture sites. Translocated bears were ear-tagged and data were collated in 1967–1974, from sightings or recaptures.

A review of 19 studies in forested areas in 16 states and provinces in the USA and Canada (2) found that black bears *Ursus americanus* translocated away from sites of conflict with humans were less likely to return to their capture site if translocated as younger bears, over greater distances, or across geographic barriers. Of 15 sub-adult male bears translocated 32–85 km (pooled from two studies), one returned to

its capture site, compared to 106 returns out of 145 bears >2 years old translocated 8–120 km (pooled from 12 studies). In data pooled from 12 studies, fewer bears (34 of 79 bears -43%) that were translocated 64–271 km returned to capture locations than bears translocated <64 km (81 of 100 bears — 81%). In one study of bears translocated ≤80 km, fewer returned when released at locations separated from capture sites by mountains or numerous ridges (5 of 27 bears — 19%) than when released across more uniform terrain (104 of 143 bears — 73%). Translocation and movement data were summarized from 19 studies (16 published in 1961–1984 and three unpublished) of bears translocated due to nuisance behaviour. Bears were considered to have returned home if found within 8–20 km of their capture site (this varied by study).

(1) Beeman L.E. & Pelton M.R. (1976) Homing of black bears in the Great Smoky Mountains National Park. *Bears: Their Biology and Management*, 3, 87–95.

(2) Rogers L.L. (1986) Effects of translocation distance on frequency of return by adult black bears. *Wildlife Society Bulletin*, 14, 76–80.

7.9. Treat mammals to reduce conflict caused by disease transmission to humans

https://www.conservationevidence.com/actions/2342

- **One study** evaluated the effects of treating mammals to reduce conflict caused by disease transmission to humans. This study was in Germany[1].

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

- **Human-wildlife conflict (1 study):** A controlled, before-and-after study in Germany[1] found that following a worming programme, proportions of red foxes infested with small fox tapeworm fell.

Background

Outbreaks of diseases that can be spread between animals and humans (zoonotic diseases) may result in calls for lethal control of the relevant carrier species. Motivations for lethal control may be reduced if the prevalence of diseases or parasites can be reduced by carrying out treatments in wild populations. This intervention specifically considers ways of reducing the risk of disease transmission to humans rather than ways of reducing the direct impact of disease on wild mammal populations.

A controlled, before-and-after study from 2005–2007 in rural and urban areas in Starnberg, Germany (1) found that following a worming programme, proportions of red foxes *Vulpes vulpes* infested with small fox tapeworm *Echinococcus multicularis* decreased. From four to 15 months after worming, a lower proportion of foxes (0.8%) was infested with tapeworms than was infested in untreated areas (33%). Before worming, the proportion infested was similar in areas to be treated (35%) and not treated (43%). From December 2005–March 2007, fox baits (Droncit®) laced with 50 mg of praziquantel were distributed by air in agricultural and recreational areas and by hand in towns and villages. Baits were distributed once every four weeks, over a 213-km^2 area, at a density of 50 baits/km^2. Additional bait was left around 100 den sites in January–February and June–August. No bait was distributed in a 238-km^2 control area. Tapeworm infestation levels were diagnosed in dissected foxes killed by hunters (133 before baiting and 123 after baiting). Small fox tapeworm causes alveolar echinococcosis in humans.

(1) König A., Romig T., Janko C., Hildenbrand R., Holzhofer E., Kotulski Y., Ludt C., Merli M., Eggenhofer S., Thoma D. & Vilsmeier J. (2008) Integrated-baiting concept against *Echinococcus multilocularis* in foxes is successful in southern Bavaria, Germany. *European Journal of Wildlife Research*, 54, 439–447, https://doi.org/10.1007/s10344-007-0168-1

7.10. Use conditioned taste aversion to reduce human-wildlife conflict in non-residential sites

https://www.conservationevidence.com/actions/2384

- **Two studies** evaluated the effects on mammals of using conditioned taste aversion to reduce human-wildlife conflict in non-residential sites. Both studies were in the USA[1,2].

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

- **Human-wildlife conflict (2 studies):** Two studies, in the USA[1,2], found that lacing foodstuffs with substances that induce illness led to these foods being avoided by coyotes[1] and black bears[2].

Background

Some animals, such as bears, may exhibit 'nuisance behaviour' that may bring them into conflict with humans. This may especially be caused by animals attempting to raid foodstuffs, such as at campgrounds, picnic areas or other places that people gather. As well as causing damage to property and spreading rubbish, such animals may then be perceived as representing a threat to humans. As an alternative to lethal control, attempts may be made to make these animals associate human food sources with pain or discomfort by lacing foodstuffs with substances that cause gastrointestinal upset. If successful, such animals may subsequently avoid seeking out human sources of food.

Studies considered under this intervention are those concerning human-wildlife conflict away from permanent settlements. For related interventions, see also the Chapter, *Residential & commercial development*.

A study in 1977–1978 at a campsite in California, USA (1) found that using conditioned taste aversion reduced the number of coyotes *Canis latrans* that begged for food. Three months after adding lithium chloride (which induces gastrointestinal discomfort) to bait there had been no reported begging problems at the campsite, compared to >12 coyotes begging for food in the month prior to use of lithium chloride baits. Bait was consumed by coyotes 31 times over a 14-day period. From December 1977 to January 1978, meat bait was mixed with lithium chloride at a rate of 10 g/396 g of meat. Bait was left on paper plates at the campsite or thrown to individual coyotes. Animal calls were used to attract coyotes. During baiting, campsite visitors were asked not to feed coyotes. Methods for surveying coyotes were unclear in the original paper.

A study in 1992–1994 in a predominantly forested area in Minnesota, USA (2) found that inducing conditioned taste aversion through lacing military-issue meals with thiabendazole led to black bears *Ursus americanus* subsequently avoiding these foods. Consumption of laced meals induced illness in bears in <90 minutes. Thereafter, over 2–122 days post-treatment, bears did not consume military-issue meals offered during 32 of 41 trials and partially consumed such meals during nine trials. Only once did partial consumption comprise >50% of the meal. Other foodstuffs were, at least partially, consumed in 78% of trials. One year later, two of the bears did not consume military-issue meals in any of seven trials. However, one more year later, in a single trial, one of the bears fully consumed a military-issue meal. In May 1992, two adult female bears and three yearlings that were resident on a military reservation were each given a military-issue meal laced with thiabendazole (72–165 mg/kg bear). Bears were habituated to humans and could be studied closely without disturbance. Meals were ready to eat and consisted of a range of foods, each in sealed pouches and all in a sealed brown plastic bag. Subsequent trials involved military-issue meals and other foodstuffs (raw bacon, jelly, or peanut butter and jelly on bread).

(1) Cornell D. & Cornely J.E. (1979) Aversive conditioning of campground coyotes in Joshua Tree National Monument. *Wildlife Society Bulletin*, 7, 129–131.

(2) Ternent M. & Garshelis D. (1999) Taste-aversion conditioning to reduce nuisance activity by black bears in a Minnesota military reservation. *Wildlife Society Bulletin*, 27, 720–728.

7.11 Use non-lethal methods to deter carnivores from attacking humans

https://www.conservationevidence.com/actions/2385

- **Eight studies** evaluated the effects of using non-lethal methods to deter carnivores from attacking humans. Three studies were in the USA[1,2,3], two were in Australia[6,8], one was in the USA and Canada[4], one was in Austria[5] and one was in Bangladesh[7].

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

- **Survival (1 study):** A study in Bangladesh[7] found that when domestic dogs accompanied people to give advance warning of tiger presence, fewer tigers were killed by people.

BEHAVIOUR (0 STUDIES)

OTHER (8 STUDIES)

- **Human-wildlife conflict (8 studies):** Two studies, in the USA[1,4] and Canada[4], found that pepper spray caused all[1] or most[4] American black bears[1,4] and grizzly bears[4] to flee or cease aggressive behaviour. One of these studies also showed that tear gas repelled half of American black bears[1]. Two studies in the USA[3] and Austria[5] found that grizzly/brown bears were repelled by rubber bullets[3] or by a range of deterrents including rubber bullets, chasing, shouting and throwing items[5]. A study in the USA[2] found that hikers wearing bear bells were less likely to be approached or charged by grizzly bears than were hikers without bells. A replicated, controlled study in Australia[6] found that ultrasonic sound deterrent units did not affect feeding location choices of dingoes. A study in Bangladesh[7] found that domestic dogs accompanying people

gave advance warning of tiger presence, enabling people to take precautionary actions. A study in Australia[8] found that a motorised water pistol caused most dingoes to change direction or speed or move ≥5 m away, but sounding a horn did not.

Background

Actual or perceived danger to humans from carnivores can prompt lethal control of such animals. If measures can be introduced to reduce these threats, or threatening behaviour, this could reduce human-wildlife conflict and motivations for carrying out lethal control.

For related studies, see *Habituate mammals to visitors* and *Use conditioned taste aversion to reduce human-wildlife conflict in non-residential sites*. Additionally, several other interventions aim to reduce behaviour by wild mammals deemed to be a nuisance (such as raiding garbage containers) and, by reducing the extent to which carnivores and humans come into conflict, may also reduce the chances of attacks on humans. See, for example, *Residential & commercial development -Scare or otherwise deter mammals from human-occupied areas to reduce human-wildlife conflict* and *Residential & commercial development -Prevent mammals accessing potential wildlife food sources or denning sites to reduce nuisance behaviour and human-wildlife conflict*.

A study (year not stated) at campgrounds and garbage dumps in Minnesota and Michigan, USA (1) found that pepper spray repelled all American black bears *Ursus americanus* and tear gas repelled half of bears. Four out of five bears sprayed once in the eyes with pepper spray fled 7–20 m away and did not return. The fifth bear, a male, only fled after being sprayed four times (although on two occasions, the spray did not reach the bear's eye). Four bears exposed to tear gas left the site. However, two returned within a few minutes. No animals exhibited signs of aggression. The study was conducted in sites (number not stated) where black bears were reported to be taking food from people. Five

black bears were sprayed in the eyes with pepper spray from distances of 1.5–3.0 m and four were sprayed with tear gas.

A study in 1980–1981 in forest in a national park in Wyoming, USA (2) found that hikers wearing bear bells were less likely to be approached or charged by grizzly bears *Ursus arctos*. Of initially motionless bears spotted ≤150 m from hikers, a higher proportion (67%) moved away from hikers with bells than from hikers without bells (26%). No bears charged at hikers with bells, whereas 14% of bears spotted by hikers without bells charged at the hikers. Hikers reported 97 observations of bears within 150 m. In 24% of encounters, hikers wore bells. Human-bear encounters in a 154-km^2 study area were surveyed from 3 June–15 September 1980 and 14 June–22 September 1981. Bell-wearing rates were assessed during timed counts of hikers on trails, at 15-day intervals. Hikers were questioned about bear encounters.

A study in 1986–1989 at seven sites in two national parks dominated by temperate forest in Wyoming, USA (3) found that using rubber bullets to scare problem grizzly bears *Ursus arctos* caused all bears to flee from study sites, at least for a short period. Five bears were shot at using rubber bullets, 41 times in total, with 27 hits recorded and bears fled each time. Bears were generally deterred from returning to the study area for 2–4 weeks. However, two bears continued to exhibit nuisance behaviour and repeatedly exploited sources of human food. Rubber bullets were fired at bears that had been seeking human food or foraging close to habitation. The behaviour of each bear was noted before and after the firing of bullets, as well as whether the bear fled from an area with a radius of approximately 100 m.

A study in 1984–1994 across the USA (primarily Alaska and Montana) and Canada (primarily British Columbia and Alberta) (4) found that after being sprayed with pepper spray, most brown bears *Ursus arctos* and American black bears *Ursus americanus* changed their behaviour. Fifteen out of 16 (94%) brown bears and all four (100%) black bears involved in close-range aggressive encounters with people changed the behaviour after being sprayed. However, in six cases (38%), brown bears continued to act aggressively and in three cases (19%) bears attacked the person spraying. Black bears did not leave the area after being sprayed. Sixty-six records of bear-human interactions involving pepper-spray use were collected from agencies throughout Canada and the USA and from

individuals that used spray to deter bears. Results reported here are those involving close-range encounters with aggressive bears. Sprays used were thought to likely contain 10% capsicum extract.

A study in 1995–2000 of seven animals across a mixed, but mostly forested, landscape in central Austria (5) found that shooting rubber bullets, chasing, shouting and throwing items to reduce brown bears' *Ursus arctos* habituation to humans was partially successful. After 16 aversive conditioning treatments on seven bears, they returned to the site of treatment within <1 day to >6 months. The time to their next observed habituated behaviour (being ≤50 m from an observer and behaving in an indifferent or curious manner) was one week to three years. Aversive treatments, some in combination, included five capture events, 11 discharges of rubber bullets, four uses of cracker shells and two of fireworks and warning shots. Bears were monitored through reported sightings and footprint tracking. Three bears were also tracked using radio-collars and ear transmitters, but these became detached from two bears.

A replicated, controlled study (year not stated) on captive animals in Queensland, Australia (6) found that ultrasonic sound deterrent units, tested as potential deterrents for dingoes *Canis lupus dingo*, did not affect feeding location choices. Dingoes first selected bait in front of one ultrasonic unit (unit 1 of two) on 21% of occasions when it was turned on. This did not differ significantly from the 29% of occasions that unit 1 was selected first when it was turned off and unit 2 was turned on. Four captive dingoes were housed in pens, opening onto a communal area. Two ultrasonic units (Weitech Yard and Garden Protector) were positioned back to back, with 5 g of tuna in front of each. One unit (selected randomly) was turned on. Dingoes, individually in random order, were released into the communal area, and bait selection order noted. Sixty such trials were conducted.

A study in 2005–2007 in a mangrove area in Bangladesh (7) found that domestic dogs *Canis lupus familiaris* accompanying people gave advance warning of tiger *Panthera tigris* presence, enabling people to take precautionary actions. Of the responses by dogs to apparent tiger presence 62% were verified as accurate. One tiger was killed by people during 2006 (within the study period), compared to 12 in the preceding four years (most of which was before the study period). Four humans

were killed by tigers during 2006, compared to 75 over the preceding four years. Forty domestic dogs were each taken into the forest 18 times between August 2005 and January 2007. Each dog, tethered to a person, accompanied a group of 5–7 people (plant-product harvesters, honey gatherers or fishermen). Dogs responded to most wild animals with excitement, quick movements and vocalisations, though apparent responses to tigers were fear and low noise and moving close to the owner without barking. The presence of tigers or other wild animals was verified immediately by observation, or the next day by locating pugmarks or scats.

A study in 2015 at a beach in Queensland, Australia (8) found that a motorised water pistol caused dingoes *Canis dingo* to display aversive responses (change direction or speed or move ≥5 m away) in most cases but sounding a horn did not. The water pistol produced more aversive responses (32 from 43 trials involving seven animals) than did blowing a whistle, a treatment assumed not to deter dingoes (one aversive response from 23 trials involving nine dingoes). The air horn produced no aversive responses in 13 trials involving six animals. Trials were conducted along a beach, in daylight, during 1–15 December 2015. With dingoes ≤5 m from an observer, a whistle was blown on the first trial, involving nine animals. For subsequent trials for these animals, the whistle was followed by sounding an air horn or firing a mechanical water pistol. Some trials for individual dingoes were repeated after short gaps (2–11 trials during 1–55 minutes).

(1) Rogers L.L. (1984) Reactions of free-ranging black bears to capsaicin spray repellent. *Wildlife Society Bulletin*, 12, 59–61.

(2) Jope K.J. (1985) Implications of grizzly bear habituation to hikers. *Wildlife Society Bulletin*, 13, 32–37.

(3) Gillin C.M., Hammond F.M. & Peterson, C.M. (1994) Evaluation of an aversive conditioning technique used on female grizzly bears in the Yellowstone Ecosystem. *Bears: Their Biology and Management*, 9, 503–512.

(4) Herrero S. & Higgins A. (1998) Field use of capsicum spray as a bear deterrent. *Ursus*, 10, 533–537.

(5) Rauer G., Kaczensky P. & Knauer F. (2003) Experiences with aversive conditioning of habituated brown bears in Austria and other European countries. *Ursus*, 14, 215–224.

(6) Edgar J.P., Appleby R.G. & Jones D.N. (2007) Efficacy of an ultrasonic device as a deterrent to dingoes (*Canis lupus dingo*): a preliminary investigation. *Journal of Ethology*, 25, 209–213, https://doi.org/10.1007/s10164-006-0004-1

(7) Khan M.M.H. (2009) Can domestic dogs save humans from tigers *Panthera tigris*? *Oryx*, 43, 44–47, https://doi.org/10.1017/s0030605308002068

(8) Appleby R., Smith B., Mackie J., Bernede L. & Jones D. (2017) Preliminary observations of dingo responses to assumed aversive stimuli. *Pacific Conservation Biology*, 23, 295–301, https://doi.org/10.1071/pc17005