



Conservation
Evidence

Providing Evidence to Improve Practice



What Works in Conservation



2021

EDITED BY

WILLIAM J. SUTHERLAND, LYNN V. DICKS,
SILVIU O. PETROVAN AND REBECCA K. SMITH



<http://www.openbookpublishers.com>

© 2021 William J. Sutherland



This work is licensed under a Creative Commons Attribution 4.0 International license (CC BY 4.0). This license allows you to share, copy, distribute and transmit the work; to adapt the work and to make commercial use of the work providing attribution is made to the authors (but not in any way that suggests that they endorse you or your use of the work). Attribution should include the following information:

Sutherland, W.J., Dicks, L.V., Petrovan, S.O., and Smith, R.K. *What Works in Conservation 2021*. Cambridge, UK: Open Book Publishers, 2021. <https://doi.org/10.11647/OBP.0267>

In order to access detailed and updated information on the license, please visit <https://www.openbookpublishers.com/product/1490#copyright>

Further details about CC BY licenses are available at <http://creativecommons.org/licenses/by/4.0/>

All links were active at the time of publication unless otherwise stated.

Digital material and resources associated with this volume are available at <https://www.openbookpublishers.com/product/1490#resources> and <http://www.conservationevidence.com>

What Works in Conservation Series | ISSN: 2059-4232 (Print); 2059-4240 (Online)

ISBN Paperback: 978-1-80064-272-0

ISBN Hardback: 978-1-80064-273-7

ISBN Digital (PDF): 978-1-80064-274-4

ISBN Digital ebook (epub): 978-1-80064-275-1

ISBN Digital ebook (mobi): 978-1-80064-276-8

DOI: 10.11647/OBP.0267

Funded by Arcadia, DEFRA, ESRC, MAVA Foundation, NERC, Natural England, Robert Bosch Stiftung, Synchronicity Earth, South West Water and Waitrose Ltd.

Cover image: A close up shot of the underside of a Dwarf Cavendish (*Musa acuminata*) by Ben Clough, CC BY-SA 3.0. Wikimedia http://commons.wikimedia.org/wiki/File:Dwarf_cavendish_leaf_2.jpg. Cover design: Heidi Coburn

15. TERRESTRIAL MAMMAL CONSERVATION

**Nick Littlewood, Ricardo Rocha, Rebecca K. Smith, Philip Martin,
Sarah Lockhart, Rebecca F. Schoonover, Elspeth Wilman, Andrew J.
Bladon, Katie A. Sainsbury, Stuart Pimm & William J. Sutherland**

Expert assessors

Jeff Bowman, Ontario Ministry of Natural Resources and Forestry, Canada
Nicolas Caruso, Universidad Nacional del Sur, Argentina
Sebastien Devillard, Claude Bernard University Lyon 1, France
Jeffrey Dunninck, Panthera, USA
Anthony Giordano, SPECIES, USA
Edson Gandiwa, Chinhoyi University of Technology, Zimbabwe
Mohd Azlan Jayasilan bin Abdul Gulam Azad, Universiti Malaysia Sarawak, Malaysia
Claude Fisher, Haute Ecole Specialisee de Suisse Occidentale, Switzerland
Igor Khorozyan, Georg-August University of Göttingen, Germany
Laura Kubasiewicz, Mammal Society, UK
Nick Littlewood, Scotland's Rural College Aberdeen, UK
Lucy Lush, Scottish Wildlife Trust, UK
Silvio Marchini, University of Sao Paolo, Brazil
Catherine McNicol, Gloucestershire Wildlife Trust, UK
William Morgan, University of Cambridge, UK
Hannah Mumby, University of Hong Kong, China
Andres Ordiz, Scandinavian Bear and Wolf Research, Norway
Silviu Petrovan, University of Cambridge, UK Sugoto Roy, IUCN, Switzerland
Viorel Popescu, University of Ohio, USA
Tharmalingam Ramesh, Sálím Ali Centre for Ornithology & Natural History, India
Neil Reid, Queen's University Belfast, UK
Alfredo Romero-Muñoz, Fundacion Cohabitar, Bolivia
Laurentiu Rozylowicz, University of Bucharest, Romania
Euan Ritchie, Deakin University, Australia
Martin Salek, The Czech Academy of Sciences, Czechia
Stephanie Schai-Braun, Universität für Bodenkultur Wien (BOKU), Austria
Henry Schofield, Vincent Wildlife Trust, UK
Ignasi Torre, Museum of Natural Sciences of Granollers, Spain
Richard Yarnell, Nottingham Trent University, UK
Susanne Vogel, Aarhus University, Denmark
Marco Zaccaroni, University of Florence, Italy
Galo Zapata-Rios, Wildlife Conservation Society, Ecuador
Diana Zlatanova, Sofia University "St. Kliment Ohridski", Bulgaria

Scope of assessment: for native wild terrestrial species across the world.

Assessed: 2021.

Effectiveness measure is the median % score for effectiveness.

Certainty measure is the median % certainty of evidence for effectiveness, determined by the quantity and quality of the evidence in the synopsis.

Harm measure is the median % score for negative side-effects to the group of species of concern.

This book is meant as a guide to the evidence available for different conservation interventions and as a starting point in assessing their effectiveness. The assessments are based on the available evidence for the target group of species for each intervention. The assessment may therefore refer to different species or habitat to the one(s) you are considering. Before making any decisions about implementing interventions it is vital that you read the more detailed accounts of the evidence in order to assess their relevance for your study species or system.

Full details of the evidence are available at
www.conservationevidence.com

There may also be significant negative side-effects on the target groups or other species or communities that have not been identified in this assessment.

A lack of evidence means that we have been unable to assess whether or not an intervention is effective or has any harmful impacts.

15.1 Threat: Residential and commercial development

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for residential and commercial development?	
Beneficial	<ul style="list-style-type: none"> • Use collar-mounted devices to reduce predation by domestic animals
Likely to be beneficial	<ul style="list-style-type: none"> • Keep cats indoors or in outside runs to reduce predation of wild mammals • Prevent mammals accessing potential wildlife food sources or denning sites to reduce nuisance behaviour and human-wildlife conflict • Scare or otherwise deter mammals from human-occupied areas to reduce human-wildlife conflict
Unknown effectiveness	<ul style="list-style-type: none"> • Install underpasses beneath ski runs • Issue enforcement notices to deter use of non bear-proof garbage dumpsters to reduce human-wildlife conflict • Provide diversionary feeding for mammals to reduce nuisance behaviour and human-wildlife conflict • Provide woody debris in ski run area • Retain wildlife corridors in residential areas
Likely to be ineffective or harmful	<ul style="list-style-type: none"> • Translocate problem mammals away from residential areas (e.g. habituated bears) to reduce human-wildlife conflict

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for residential and commercial development?	
No evidence found (no assessment)	<ul style="list-style-type: none">• Keep dogs indoors or in outside enclosures to reduce threats to wild mammals• Keep domestic cats and dogs well-fed to reduce predation of wild mammals• Protect mammals close to development areas (e.g. by fencing)

Beneficial

● Use collar-mounted devices to reduce predation by domestic animals

Five studies evaluated the effects on mammals of using collar-mounted devices to reduce predation by domestic animals. Three studies were in the UK, one was in Australia and one was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (5 STUDIES)

Survival (5 studies): Five replicated studies (including four randomized, controlled studies), in the UK, Australia and the USA, found that bells, a sonic device, and a neoprene flap (which inhibits pouncing) mounted on collars, and a brightly coloured and patterned collar all reduced the rate at which cats preyed and returned home with mammals. In one of these studies, an effect was only found in autumn, and not in spring.

BEHAVIOUR (0 STUDIES)

Assessment: beneficial (effectiveness 63%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2332>

Likely to be beneficial

● Keep cats indoors or in outside runs to reduce predation of wild mammals

One study evaluated the effects on potential prey mammals of keeping cats indoors or in outside runs. This study was in the UK.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): One replicated study in the UK found that keeping domestic cats indoors at night reduced the number of dead or injured mammals that were brought home.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 60%; certainty 45%; harms 0%).

<https://www.conservationevidence.com/actions/2326>

● **Prevent mammals accessing potential wildlife food sources or denning sites to reduce nuisance behaviour and human-wildlife conflict**

Two studies evaluated the effects of preventing mammals accessing potential wildlife food sources or denning sites to reduce nuisance behaviour and human-wildlife conflict. One study was in the USA and one was in Switzerland.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human-wildlife conflict (2 studies): A replicated, controlled study in the USA found that electric shock devices prevented American black bears from accessing or damaging bird feeders. A before-and-after study in Switzerland found that electric fencing excluded stone martens from a building.

Assessment: likely to be beneficial (effectiveness 80%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2346>

● **Scare or otherwise deter mammals from human-occupied areas to reduce human-wildlife conflict**

Ten studies evaluated the effects of scaring or otherwise deterring mammals from residential areas to reduce human-wildlife conflict. Six studies were in the USA, three were in Canada and one was in Tanzania.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (10 STUDIES)

Human-wildlife conflict (10 studies): Two of four studies (including one randomized and controlled study) in the USA, found that a range of noise

and pain deterrents did not prevent black bears from returning to urban areas or other human-occupied sites. The other two studies found that such actions did deter them from seeking food at human-occupied sites. Two of three studies, in the USA and Canada, found that chasing nuisance black bears with dogs and chasing elk with people or dogs caused them to stay away longer or remain further from human occupied areas. The other study found that attempts to scare coyotes did not cause them to avoid human occupied areas. A before-and-after study in Canada found that an electric fence prevented polar bear entry to a compound. A study in Canada found that chemical and acoustic repellents did not deter polar bears from baits in most cases. A replicated study in Tanzania found that drones caused African savanna elephants to quickly leave residential areas.

Assessment: likely to be beneficial (effectiveness 50%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2347>

Unknown effectiveness

● **Install underpasses beneath ski runs**

One study evaluated the effects on mammals of installing underpasses beneath ski runs. This study was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated study in Australia found that boulder-filled crossings beneath ski slopes were used by seven small mammal species.

Assessment: unknown effectiveness (effectiveness 50%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2355>

● **Issue enforcement notices to deter use of non bear-proof garbage dumpsters to reduce human-wildlife conflict**

One study evaluated the effects of issuing enforcement notices to deter use of non bear-proof garbage dumpsters to reduce human-wildlife conflict.

This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated, controlled, before-and-after study in the USA found that issuing enforcement notices requiring appropriate dumpster use did not reduce garbage accessibility to black bears.

Assessment: unknown effectiveness (effectiveness 10%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2345>

● **Provide diversionary feeding for mammals to reduce nuisance behaviour and human-wildlife conflict**

Three studies evaluated the effects of providing diversionary feeding for mammals to reduce nuisance behaviour and human-wildlife conflict. Two studies were in the USA and one was in Slovenia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Uptake (1 study): A site comparison study in Slovenia found that 22-63% of the estimated annual energy content of the diet of brown bears comprised provided diversionary food.

OTHER (2 STUDIES)

Human-wildlife conflict (2 studies): Two before-and-after studies (one also a site comparison) in the USA found that diversionary feeding reduced nuisance behaviour by black bears.

Assessment: unknown effectiveness (effectiveness 60%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2323>

● **Provide woody debris in ski run area**

One study evaluated the effects on mammals of providing woody debris in ski run areas. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A controlled study in the USA found that placing woody debris on ski slopes did not affect overall small mammal abundance and had mixed effects on individual species abundances.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 27%; certainty 27%; harms 0%).

<https://www.conservationevidence.com/actions/2356>

● **Retain wildlife corridors in residential areas**

One study evaluated the effects on mammals of retaining wildlife corridors in residential areas. This study was in Botswana.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated study in Botswana found that retained wildlife corridors in residential areas were used by 19 mammal species, including African elephants.

Assessment: unknown effectiveness (effectiveness 61%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2354>

Likely to be ineffective or harmful

● **Translocate problem mammals away from residential areas (e.g. habituated bears) to reduce human-wildlife conflict**

Eleven studies evaluated the effects of translocating problem mammals (such as bears) away from residential areas to reduce human-wildlife conflict. Six studies were in the USA, two were in Canada, one was in Russia, one was in India and one was in Romania.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (6 STUDIES)

Survival (6 studies): A controlled study in the USA found that grizzly bears translocated away from conflict situations had lower survival rates than did non-translocated bears. A replicated study in the USA found that fewer than half of black bears translocated from conflict situations survived after one year. Two of three studies (two controlled), in the USA, found that after translocation away from urban sites, white-tailed deer survival was lower than that of non-translocated deer. The third study found that short-term survival was lower but long-term survival was higher than that of non-translocated deer. A study in Russia found that most Amur tigers translocated after attacking dogs or people did not survive for a year after release.

BEHAVIOUR (0 STUDIES)

OTHER (6 STUDIES)

Human-wildlife conflict (6 studies): Five studies (including one controlled and two replicated studies), in the USA and Canada, of brown/grizzly or black

bears translocated away from residential areas or human-related facilities, found that at least some returned to their original capture location and/or continued to cause nuisance. In two of the studies, most returned to their capture area and one black bear returned six times following translocation. A before-and-after study in India found that leopards translocated away from human-dominated areas, attacked more humans and livestock than before-translocation. A controlled study in Romania found that translocated brown bears occurred less frequently inside high potential conflict areas than outside, the opposite to bears that had not been translocated.

Assessment: likely to be ineffective or harmful (effectiveness 31%; certainty 60%; harms 50%).

<https://www.conservationevidence.com/actions/2336>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Keep dogs indoors or in outside enclosures to reduce threats to wild mammals
- Keep domestic cats and dogs well-fed to reduce predation of wild mammals
- Protect mammals close to development areas (e.g. by fencing).

15.2 Threat: Agriculture and aquaculture

15.2.1 All farming systems

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for all farming systems?	
Beneficial	<ul style="list-style-type: none"> • Create uncultivated margins around intensive arable or pasture fields
Likely to be beneficial	<ul style="list-style-type: none"> • Establish wild flower areas on farmland • Pay farmers to cover the costs of conservation measures • Plant new or maintain existing hedgerows on farmland • Plant trees on farmland • Provide or retain set-aside areas on farmland
Unknown effectiveness	<ul style="list-style-type: none"> • Use repellent on slug pellets to reduce non-target poisoning
No evidence found (no assessment)	<ul style="list-style-type: none"> • Maintain/restore/create habitat connectivity on farmland • Manage hedgerows to benefit wildlife on farmland • Provide refuges during crop harvesting or mowing • Restrict use of rodent poisons on farmland with high secondary poisoning risk



Beneficial

● Create uncultivated margins around intensive arable or pasture fields

Nine studies evaluated the effect of creating uncultivated margins around intensive arable, cropped grass or pasture fields on mammals. Six studies were in the UK, two were in Switzerland and one was in the USA.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): One replicated, controlled study in the UK found more small mammal species in uncultivated field margins than in blocks of set-aside.

POPULATION RESPONSE (9 STUDIES)

Abundance (9 studies): One replicated, randomized, controlled study in the USA found more small mammals in uncultivated and unmown field margins than in frequently mown margins. Three of seven replicated, site comparison studies (one randomized), in the UK and Switzerland, found that uncultivated field margins had higher numbers of small mammals, bank voles and brown hares relative to crops (including grassland) and set-aside. The other four studies reported mixed or no effects on bank voles, wood mice and common shrews, small mammals and brown hares. One site comparison study in the UK found that brown hares used grassy field margins more than expected based on their availability.

BEHAVIOUR (0 STUDIES)

Assessment: beneficial (effectiveness 70%; certainty 65%; harms 0%).

<https://www.conservationevidence.com/actions/2365>

Likely to be beneficial

● Establish wild flower areas on farmland

Four studies evaluated the effects of establishing wild flower areas on farmland on small mammals. Two studies were in Switzerland, one in the UK and one in Germany.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (4 STUDIES)

Abundance (4 studies): Three of four site comparison studies (including three replicated studies), in Switzerland, the UK and Germany, found that sown wildflower areas contained more wood mice, small mammals and

common hamsters compared to grass and clover set-aside, grasslands, crop and uncultivated margins, agricultural areas and crop fields.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 70%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2359>

● **Pay farmers to cover the costs of conservation measures**

Three studies evaluated the effects on mammals of paying farmers to cover the costs of conservation measures. The three studies were in the UK.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Abundance (3 studies): A replicated, controlled study, in the UK found that agri-environment scheme enrolment was associated with increased brown hare density in one of two regions studied. A replicated, site comparison study in Northern Ireland, UK found that agri-environment scheme enrolment did not increase numbers of Irish hares. A replicated, controlled study in the UK found that in field margins created through enrolment in an agri-environment scheme, small mammal abundance in spring increased, whereas it remained stable in conventionally managed margins.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 57%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2387>

● **Plant new or maintain existing hedgerows on farmland**

Three studies evaluated the effects on mammals of planting new or maintaining existing hedgerows on farmland. Two studies were in the UK and one was in Switzerland.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Abundance (3 studies): One of two replicated, site comparison studies, in the UK and Switzerland, found that retaining and enhancing hedgerows along with other field boundary features was associated with higher brown hare density in arable sites but not in grassland sites while the other study found that Irish hare numbers did not increase. A replicated, site comparison study in the UK found that establishing hedgerows alongside arable land increased small mammal abundance.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 60%; certainty 45%; harms 0%).

<https://www.conservationevidence.com/actions/2383>

● **Plant trees on farmland**

Four studies evaluated the effects on mammals of planting trees on farmland. Two studies were in the UK, one was in Italy and one was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): Two replicated studies (including one controlled, and one site comparison study), in the UK, found that farm woodland supported a higher small mammal abundance than on arable land or similar abundance compared to uncultivated field margins and set-aside.

BEHAVIOUR (2 STUDIES)

Use (2 studies): A study in Italy found that tree stands were used more by European hares compared to the wider farmed landscape. A replicated study in Australia found that trees planted on farmland were used by koalas.

Assessment: likely to be beneficial (effectiveness 70%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2386>

● **Provide or retain set-aside areas on farmland**

Four studies evaluated the effects on mammals of providing or retaining set-aside areas on farmland. Three studies were in the UK and one was in Switzerland.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Abundance (3 studies): Three replicated studies (including two site comparison studies), in the UK and Switzerland, found that set-aside did not enhance small mammal numbers relative to cropland or to uncultivated field margins and farm woodland, or brown hare numbers relative to numbers on farms without set-aside areas.

BEHAVIOUR (1 STUDY)

Use (1 study): A before-and-after study in the UK found that use of uncut set-aside areas by wood mice increased after crop harvesting.

Assessment: likely to be beneficial (effectiveness 40%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2377>

Unknown effectiveness

● **Use repellent on slug pellets to reduce non-target poisoning**

One study evaluated the effects on mammals of using repellent on slug pellets

to reduce non-target poisoning. This study was in the UK.

KEY COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated, controlled study in the UK found that, at some concentrations, food treated with a bitter substance was consumed less by wood mice but not by bank voles or common shrews.

Assessment: unknown effectiveness (effectiveness 31%; certainty 22%; harms 10%).

<https://www.conservationevidence.com/actions/2390>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Maintain/restore/create habitat connectivity on farmland
- Manage hedgerows to benefit wildlife on farmland
- Provide refuges during crop harvesting or mowing
- Restrict use of rodent poisons on farmland with high secondary poisoning risk.

15.2.2 Annual and perennial non-timber crops

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for annual and perennial non-timber crops?	
Beneficial	<ul style="list-style-type: none"> • Plant crops to provide supplementary food for mammals
Unknown effectiveness	<ul style="list-style-type: none"> • Create beetle banks on farmland • Establish long-term cover on erodible cropland • Leave cut vegetation in field to provide cover
No evidence found (no assessment)	<ul style="list-style-type: none"> • Change mowing regime (e.g. timing, frequency, height) • Increase crop diversity for mammals • Leave areas of uncut ryegrass in silage field

Beneficial

● Plant crops to provide supplementary food for mammals

Four studies evaluated the effects on mammals of planting crops to provide supplementary food. Two studies were in the USA, one was in the UK and one was in Spain.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Abundance (3 studies): Two replicated, controlled studies (including one before-and-after study), in the UK and Spain, found that crops grown to provide food for wildlife resulted in a higher abundance of small mammals in winter, but not in summer and increased European rabbit abundance. A replicated, randomized, controlled study in the USA found that triticale (a cross between wheat and rye) held higher overwintering mule deer abundance relative to barley, annual ryegrass, winter wheat or rye.

BEHAVIOUR (2 STUDIES)

Use (2 studies): A replicated, randomized, controlled study in the USA found that mule deer consumed triticale (a cross between wheat and rye) more than they did barley, annual ryegrass, winter wheat or rye. A replicated, randomized, controlled study in the USA found that supplementary food provided for game species was also consumed by lagomorphs and rodents. *Assessment: beneficial (effectiveness 70%; certainty 62%; harms 0%).*

<https://www.conservationevidence.com/actions/2394>

Unknown effectiveness

● Create beetle banks on farmland

One study evaluated the effects on mammals of creating beetle banks on farmland. This study was in the UK.

KEY COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): One replicated study in the UK found that beetle banks had higher densities of harvest mouse nests than did field margins.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 60%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2393>

● **Establish long-term cover on erodible cropland**

One study evaluated the effects on mammals of establishing long-term cover on erodible cropland. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A replicated, site comparison study in the USA, found that establishing long-term cover on erodible cropland did not increase the abundance of eastern cottontails.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 7%; certainty 27%; harms 0%).

<https://www.conservationevidence.com/actions/2402>

● **Leave cut vegetation in field to provide cover**

One study evaluated the effects on mammals of leaving cut vegetation in field to provide cover. This study was in the USA

KEY COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A controlled, before-and-after study in the USA found that increasing cover, by adding cut vegetation (hay), did not increase rodent abundance.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 3%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2401>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Change mowing regime (e.g. timing, frequency, height)
- Increase crop diversity for mammals
- Leave areas of uncut ryegrass in silage field.

15.2.3 Livestock farming and ranching

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for livestock farming and ranching?	
Beneficial	<ul style="list-style-type: none"> • Reduce intensity of grazing by domestic livestock
Likely to be beneficial	<ul style="list-style-type: none"> • Change type of livestock • Exclude livestock from semi-natural habitat (including woodland) • Install mammal crossing points along fences on farmland • Use livestock fences that are permeable to wildlife
Unknown effectiveness	<ul style="list-style-type: none"> • Use traditional breeds of livestock

Beneficial

● Reduce intensity of grazing by domestic livestock

Thirteen studies evaluated the effects on mammals of reducing the intensity of grazing by domestic livestock. Six studies were in the USA, six were in Europe and one was in China.

COMMUNITY RESPONSE (3 STUDIES)

Richness/diversity (3 studies): Two of three site comparison or controlled studies, in the USA and Norway, found that reduced livestock grazing intensity was associated with increased species richness of small mammals whilst one study did not find an increase in species richness.

POPULATION RESPONSE (13 STUDIES)

Abundance (13 studies): Six of nine site comparison or controlled studies (including seven replicated studies), in the USA, Denmark, the UK, China, Netherlands and Norway, found that reductions in livestock grazing intensity were associated with increases in abundances (or proxies of abundances) of small mammals, whilst two studies showed no significant impact of reducing grazing intensity and one study showed mixed results for different species. Two replicated studies (including one controlled and one site comparison study), in the UK and in a range of European countries, found that reducing

grazing intensity did not increase numbers of Irish hares or European hares. A controlled, before-and-after study, in the USA found that exclusion of cattle grazing was associated with higher numbers of elk and mule deer. A replicated, site comparison study in the USA found that an absence of cattle grazing was associated with higher numbers of North American beavers.

BEHAVIOUR (0 STUDIES)

Assessment: beneficial (effectiveness 70%; certainty 65%; harms 0%).

<https://www.conservationevidence.com/actions/2408>

Likely to be beneficial

● Change type of livestock

Two studies evaluated the effect of changing type of livestock on mammals. One study was in the UK and one was in the Netherlands.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): One replicated, randomized, paired sites, controlled, before-and-after study in the UK found that sheep and cattle grazing increased field vole abundance relative to sheep-only grazing. One replicated, randomized, paired sites study in the Netherlands found that cattle grazing increased vole abundance relative to horse grazing.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 62%; certainty 41%; harms 0%).

<https://www.conservationevidence.com/actions/2412>

● Exclude livestock from semi-natural habitat (including woodland)

Nine studies evaluated the effects of excluding livestock from semi-natural habitat on mammals. Six studies were in the USA, two were in Spain and one was in Australia.

COMMUNITY RESPONSE (2 STUDIES)

Richness/diversity (2 studies): Two replicated, site comparison studies in the USA found more small mammal species on areas from which livestock were excluded.

POPULATION RESPONSE (9 STUDIES)

Abundance (9 studies): Four out of eight studies (including four site comparisons and four controlled studies), in the USA and Spain, found that excluding grazing livestock led to higher abundances of mule deer,

small mammals and, when combined with provision of water, of European rabbits. One study found higher densities of some but not all small mammals species when livestock were excluded and the other three studies found that grazing exclusion did not lead to higher abundances of black-tailed hares, California ground squirrel burrows or of five small mammal species. A site comparison study in Australia found more small mammals where cattle were excluded compared to high intensity cattle-grazing but not compared to medium or low cattle-grazing intensities.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 67%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2407>

● **Install mammal crossing points along fences on farmland**

Four studies evaluated the effects on mammals of installing mammal crossing points along fences on farmland. Two studies were in Namibia and one each was in the USA and the UK.

KEY COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (4 STUDIES)

Use (4 studies): A study in the USA found that pronghorn antelopes crossed a modified cattle grid which prevented escape of domestic sheep and cows. A controlled, before-and-after study in Namibia found installing swing gates through game fencing reduced the digging of holes by animals under the fence, whilst preventing large predator entry. A study in the UK found that a vertical-sided ditch under an electric fence allowed access by otters. A before-and-after study in Namibia found that tyres installed as crossings through fences were used by wild mammals and reduced fence maintenance requirements.

Assessment: likely to be beneficial (effectiveness 70%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2410>

● **Use livestock fences that are permeable to wildlife**

Two studies evaluated the effects on target mammals of using livestock fences that are permeable to wildlife. Both studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (2 STUDIES)

Use (2 studies): A study in the USA found that wild ungulates crossed

a triangular cross-section fence with varying success rates. A replicated, controlled study in the USA found that fences with a lowered top wire were crossed more by elk than were conventional fences.

Assessment: likely to be beneficial (effectiveness 60%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2409>

Unknown effectiveness

● Use traditional breeds of livestock

One study evaluated the effects of using traditional breeds of livestock on wild mammals. This study was carried out in four European countries.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated, randomized, controlled study in Europe found that European hares did not use areas grazed by traditional livestock breeds more than they used areas grazed by commercial breeds.

Assessment: unknown effectiveness (effectiveness 0%; certainty 10%; harms 0%).

<https://www.conservationevidence.com/actions/2411>

15.2.4 Reduce human-wildlife conflict

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reduce human-wildlife conflict?	
Beneficial	<ul style="list-style-type: none">• Deter predation of livestock by using shock/electronic dog-training collars to reduce human-wildlife conflict• Install electric fencing to protect crops from mammals to reduce human-wildlife conflict• Install electric fencing to reduce predation of livestock by mammals to reduce human-wildlife conflict• Install non-electric fencing to exclude predators or herbivores and reduce human-wildlife conflict• Use guardian animals (e.g. dogs, llamas, donkeys) bonded to livestock to deter predators to reduce human-wildlife conflict

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reduce human-wildlife conflict?

Likely to be beneficial

- Exclude wild mammals using ditches, moats, walls or other barricades to reduce human-wildlife conflict
- Install metal grids at field entrances to prevent mammals entering to reduce human-wildlife conflict
- Keep livestock in enclosures to reduce predation by mammals to reduce human-wildlife conflict
- Pay farmers to compensate for losses due to predators/wild herbivores to reduce human-wildlife conflict
- Provide diversionary feeding to reduce crop damage by mammals to reduce human-wildlife conflict
- Use bees to deter crop damage by mammals (e.g. elephants) to reduce human-wildlife conflict
- Use chili to deter crop damage by mammals to reduce human-wildlife conflict
- Use fire to deter crop damage by mammals to reduce human-wildlife conflict
- Use flags to reduce predation of livestock by mammals to reduce human-wildlife conflict
- Use lights and sound to deter predation of livestock by mammals to reduce human-wildlife conflict
- Use loud noises to deter crop damage (e.g. banger sticks, drums, tins, iron sheets) by mammals to reduce human-wildlife conflict
- Use loud noises to deter predation of livestock by mammals to reduce human-wildlife conflict
- Use predator scent to deter crop damage by mammals to reduce human-wildlife conflict
- Use repellents that taste bad ('contact repellents') to deter crop or property damage by mammals to reduce human-wildlife conflict
- Use scent to deter predation of livestock by mammals to reduce human-wildlife conflict

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reduce human-wildlife conflict?	
	<ul style="list-style-type: none"> • Use target species distress calls or signals to deter crop damage by mammals to reduce human-wildlife conflict • Use taste-aversion to reduce predation of livestock by mammals to deter human-wildlife conflict
Trade-off between benefit and harms	<ul style="list-style-type: none"> • Translocate crop raiders away from crops (e.g. elephants) to reduce human-wildlife conflict • Translocate predators away from livestock to reduce human-wildlife conflict
Unknown effectiveness	<ul style="list-style-type: none"> • Deter predation of livestock by herding livestock using adults instead of children to reduce human-wildlife conflict • Deter predation of livestock by mammals by having people close by to reduce human-wildlife conflict • Dispose of livestock carcasses to deter predation of livestock by mammals to reduce human-wildlife conflict • Drive wild animals away using domestic animals of the same species to reduce human-wildlife conflict • Fit livestock with protective collars to reduce risk of predation by mammals to reduce human-wildlife conflict • Install automatically closing gates at field entrances to prevent mammals entering to reduce human-wildlife conflict • Provide diversionary feeding to reduce predation of livestock by mammals to reduce human-wildlife conflict • Relocate local pastoralist communities to reduce human-wildlife conflict • Use dogs to guard crops to reduce human-wildlife conflict • Use drones to deter crop damage by mammals to reduce human-wildlife conflict • Use light/lasers to deter crop damage by mammals to reduce human-wildlife conflict • Use negative stimuli to deter consumption of livestock feed by mammals to reduce human-wildlife conflict

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reduce human-wildlife conflict?

	<ul style="list-style-type: none"> • Use noise aversive conditioning to deter crop damage by mammals to reduce human-wildlife conflict • Use repellents that smell bad ('area repellents') to deter crop or property damage by mammals to reduce human-wildlife conflict • Use target species scent to deter crop damage by mammals to reduce human-wildlife conflict • Use ultrasonic noises to deter crop damage by mammals to reduce human-wildlife conflict • Use visual deterrents (e.g. scarecrows) to deter predation of livestock by mammals to reduce human-wildlife conflict • Use 'shock collars' to deter crop damage by mammals to reduce human-wildlife conflict
<p>Unlikely to be beneficial</p>	<ul style="list-style-type: none"> • Use lights and sound to deter crop damage by mammals to reduce human-wildlife conflict
<p>No evidence found (no assessment)</p>	<ul style="list-style-type: none"> • Establish deviation ponds in fish farms to reduce predation of fish stock by mammals to reduce human-wildlife conflict • Grow unattractive crop in buffer zone around crops (e.g. chili peppers) to reduce human-wildlife conflict • Play predator calls to deter crop damage by mammals to reduce human-wildlife conflict • Use fencing/netting to reduce predation of fish stock by mammals to reduce human-wildlife conflict • Use mobile phone communications to warn farmers of problematic mammals (e.g. elephants) • Use pheromones to deter crop damage by mammals to reduce human-wildlife conflict • Use pheromones to deter predation of livestock by mammals to reduce human-wildlife conflict • Use scarecrows to deter crop damage by mammals to reduce human-wildlife conflict • Use tree nets to deter wild mammals from fruit crops to reduce human-wildlife conflict • Use watchmen to deter crop damage by mammals to reduce human-wildlife conflict

Beneficial

● **Deter predation of livestock by using shock/electronic dog-training collars to reduce human-wildlife conflict**

Five studies evaluated the effects of using shock/electronic dog-training collars to deter predation of livestock to reduce human-wildlife conflict. All five studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (5 STUDIES)

Human-wildlife conflict (5 studies): Three of four replicated studies (including two controlled studies), in the USA, found that electric shock collars reduced livestock predation or bait consumption by wolves, whilst one found that they did not reduce wolf bait consumption. One replicated, controlled study in the USA found that electric shock collars reduced the frequency of attacks by captive coyotes on lambs.

Assessment: beneficial (effectiveness 70%; certainty 67%; harms 0%).

<https://www.conservationevidence.com/actions/2446>

● **Install electric fencing to protect crops from mammals to reduce human-wildlife conflict**

Eleven studies evaluated the effects of installing electric fencing to protect crops from mammals to reduce human-wildlife conflict. Three studies were in Japan, three were in the USA, two were in the UK and one each was in Namibia, India and Guinea-Bissau.

KEY COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (11 studies)

Human-wildlife conflict (11 studies): Nine of 11 studies (including three before-and-after studies and three controlled studies), in the USA, the UK, Japan, Namibia, India and Guinea-Bissau, found that electric fences deterred crossings by mammals, ranging in size from European rabbits to elephants. Two studies had mixed results, with some fence designs deterring elephants and black bears.

Assessment: beneficial (effectiveness 80%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2439>

● **Install electric fencing to reduce predation of livestock by mammals to reduce human-wildlife conflict**

Eleven studies evaluated the effects of installing electric fencing to reduce predation of livestock by mammals to reduce human-wildlife conflict. Six studies were in the USA (and a further one was presumed to be in the USA) and one each was in Canada, South Africa, Brazil and Spain.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (11 STUDIES)

Human-wildlife conflict (11 studies): Six out of 10 randomized and/or controlled or before-and-after studies (including eight replicated studies), in the USA (and a further one presumed to be in the USA), Canada, Brazil and Spain, found that electric fences reduced or prevented entry to livestock enclosures or predation of livestock by carnivores. Two studies found that some designs of electric fencing prevented coyotes from entering enclosures and killing or wounding lambs. The other two studies found electric fencing did not reduce livestock predation or prevent fence crossings by carnivores. A before-and-after study in South Africa found that electrifying a fence reduced digging of burrows under the fence that black-backed jackals could pass through.

Assessment: beneficial (effectiveness 70%; certainty 65%; harms 5%).

<https://www.conservationevidence.com/actions/2417>

● **Install non-electric fencing to exclude predators or herbivores and reduce human-wildlife conflict**

Eight studies evaluated the effects on mammals of installing non-electric fencing to exclude predators or herbivores and reduce human-wildlife conflict. Two studies were in the USA and one each was in Germany, the UK, Spain, China, Tanzania and Kenya.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (8 STUDIES)

Human-wildlife conflict (8 studies): Four replicated studies (including three before-and-after studies), in USA, China, Tanzania and Kenya, found that non-electric fencing reduced livestock predation by coyotes, Tibetan brown bears, and a range of mammalian predators. A replicated, controlled study

in USA found that a high woven wire fence with small mesh, an overhang and an apron (to deter burrowing) was the most effective design at deterring crossings by coyotes. A replicated, controlled study in Germany found that fencing with phosphorescent tape was more effective than fencing with normal yellow tape for deterring red deer and roe deer, but had no effect on crossings by wild boar or brown hare. Two studies (one replicated, before-and-after, site comparison and one controlled study) in the UK and Spain found that fences reduced European rabbit numbers on or damage to crops. *Assessment: beneficial (effectiveness 75%; certainty 70%; harms 2%).*

<https://www.conservationevidence.com/actions/2415>

● **Use guardian animals (e.g. dogs, llamas, donkeys) bonded to livestock to deter predators to reduce human-wildlife conflict**

Twelve studies evaluated the effects of using guardian animals (e.g. dogs, llamas, donkeys) bonded to livestock to deter mammals from preying on these livestock to reduce human-wildlife conflict. Four studies were in the USA, two were in Kenya and one each was in Slovakia, Argentina, Australia, Cameroon, South Africa, and Namibia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (12 STUDIES)

Human-wildlife conflict (12 studies): Four of seven studies, (including four site comparison studies), in the USA, Kenya, Slovakia, Australia and Cameroon, found that guardian animals reduced attacks on livestock by predators. The other three studies reported mixed results with reductions in attacks on some but not all age groups or livestock species and reductions for nomadic but not resident pastoralists. Two studies, (including one site comparison study and one before-and-after study), in Argentina and Namibia, found that using dogs to guard livestock reduced the killing of predators by farmers but the number of black-backed jackals killed by farmers and dogs combined increased. A replicated, controlled study in the USA found that fewer sheep guarded by llamas were preyed on by carnivores in one of two summers whilst a replicated, before-and-after study in South Africa found that using dogs or alpacas to guard livestock reduced attacks by predators. A randomized, replicated, controlled study in USA found that dogs bonded

with livestock reduced contact between white-tailed deer and domestic cattle.
Assessment: beneficial (effectiveness 70%; certainty 67%; harms 10%).

<https://www.conservationevidence.com/actions/2433>

Likely to be beneficial

● Exclude wild mammals using ditches, moats, walls or other barricades to reduce human-wildlife conflict

Two studies evaluated the effects of excluding wild mammals using ditches, moats, walls or other barricades to reduce human-wildlife conflict. One study was in Cameroon and Benin and one was in Cameroon.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human-wildlife conflict (2 studies): Two studies (including one before-and-after study and one site comparison), in Cameroon and Benin and in Cameroon, found that fewer livestock were predated when they were kept in enclosures, especially when these were reinforced.

Assessment: likely to be beneficial (effectiveness 70%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2420>

● Install metal grids at field entrances to prevent mammals entering to reduce human-wildlife conflict

Two studies evaluated the effects on mammal incursions of installing metal grids at field entrances to reduce human-wildlife conflict. Both of these studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human-wildlife conflict (2 studies): One of two replicated studies (including one controlled study), in the USA, found that deer guards (horizontal, ground-level metal grids) reduced entry into enclosures by white-tailed deer whilst the other found that they did not prevent crossings by mule deer or elk.

Assessment: likely to be beneficial (effectiveness 50%; certainty 45%; harms 0%).

<https://www.conservationevidence.com/actions/2440>

● **Keep livestock in enclosures to reduce predation by mammals to reduce human-wildlife conflict**

One study evaluated the effects of keeping livestock in enclosures to reduce predation by mammals to reduce human-wildlife conflict. This study was in Portugal.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated study in Portugal found fewer wolf attacks on cattle on farms where cattle were confined for at least some of the time compared to those with free-ranging cattle.

Assessment: likely to be beneficial (effectiveness 70%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2438>

● **Pay farmers to compensate for losses due to predators/wild herbivores to reduce human-wildlife conflict**

Five studies evaluated the effects on mammals of paying farmers compensation for losses due to predators or wild herbivores to reduce human-wildlife conflict. Three studies were in Kenya and one each was in Italy and Sweden.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (5 STUDIES)

Abundance (2 studies): Two studies, in Italy and Sweden, found that compensating livestock owners for losses to predators led to increasing populations of wolves and wolverines.

Survival (3 studies): Three before-and-after studies (including two replicated studies), in Kenya, found that when pastoralists were compensated for livestock killings by predators, fewer lions were killed.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 80%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2414>

● **Provide diversionary feeding to reduce crop damage by mammals to reduce human-wildlife conflict**

Six studies evaluated the effects of providing diversionary feeding to reduce crop damage by mammals to reduce human-wildlife conflict. Three studies were in Canada and one was in each of France, Spain and Austria.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (6 STUDIES)

Human-wildlife conflict (6 studies): Three of six studies (including four controlled and one before-and-after study) in Canada, France, Spain and Austria found that diversionary feeding reduced damage by red squirrels to pine trees and European rabbits to grape vines, and resulted in fewer red deer using vulnerable forest stands. Two studies found that diversionary feeding did not reduce damage by voles to apple trees or wild boar to grape vines. One study found mixed results on damage by voles to crabapple trees depending on the food provided.

Assessment: likely to be beneficial (effectiveness 50%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2457>

● Use bees to deter crop damage by mammals (e.g. elephants) to reduce human-wildlife conflict

Three studies evaluated the effects on elephants of using bees to deter crop damage to reduce human-wildlife conflict. All three studies were in Kenya.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (3 STUDIES)

Human-wildlife conflict (3 studies): Three replicated studies (including one controlled study), in Kenya, found that beehive fences reduced crop raiding by African elephants.

Assessment: likely to be beneficial (effectiveness 70%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2489>

● Use chili to deter crop damage by mammals to reduce human-wildlife conflict

Seven studies evaluated the effects on elephants of using chili to deter crop damage to reduce human-wildlife conflict. Four studies were in Zimbabwe, two were in Kenya and one was in India.

KEY COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (7 STUDIES)

Human-wildlife conflict (7 studies): Five of seven studies (including four replicated and two before-and-after studies), in Zimbabwe, Kenya and India, found that chill-based deterrents (chili-spray, chili smoke, chili fences and chili extract in a projectile, in some cases along with other deterrents) repelled elephants at least initially, whilst two studies found that chili smoke (and in one case chili fences) did not reduce crop raiding.

Assessment: likely to be beneficial (effectiveness 50%; certainty 55%; harms 0%).

<https://www.conservationevidence.com/actions/2492>

● Use fire to deter crop damage by mammals to reduce human-wildlife conflict

Two studies evaluated the effects on mammals of using fire to deter crop damage by mammals to reduce human-wildlife conflict. One study was in Zimbabwe and one was in India.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human-wildlife conflict (2 studies): A replicated study in Zimbabwe found that a combination of large fires and people with drums and dogs repelled African elephants from crops faster than did a combination of people with dogs and slingshots, drums and burning sticks. A study in India found that fire reduced the chance of Asian elephants damaging crops.

Assessment: likely to be beneficial (effectiveness 55%; certainty 40%; harms 4%).

<https://www.conservationevidence.com/actions/2499>

● Use flags to reduce predation of livestock by mammals to reduce human-wildlife conflict

Five studies evaluated the effects on mammals of using flags to reduce predation of livestock by mammals to reduce human-wildlife conflict. Three studies were in the USA, one was in Italy and one was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (5 STUDIES)

Human-wildlife conflict (5 studies): Three studies (including two before-and-after studies and a controlled study), in Italy, Canada and the USA, found that flags hanging from fence lines (fladry) deterred crossings by wolves

but not by coyotes. A further replicated, controlled study in the USA found that electric fences with fladry were not crossed by wolves. A replicated, controlled, before-and-after study in the USA found that fladry did not reduce total deer carcass consumption by a range of carnivores.

Assessment: likely to be beneficial (effectiveness 50%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2421>

● **Use lights and sound to deter predation of livestock by mammals to reduce human-wildlife conflict**

Three studies evaluated the effects of using lights and sound to deter predation of livestock by mammals to reduce human-wildlife conflict. All three studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (3 STUDIES)

Human-wildlife conflict (3 studies): Three replicated studies (including one controlled study), in the USA, found that devices emitting sounds and lights deterred predators from predating sheep or consuming bait.

Assessment: likely to be beneficial (effectiveness 70%; certainty 46%; harms 0%).

<https://www.conservationevidence.com/actions/2449>

● **Use loud noises to deter crop damage (e.g. banger sticks, drums, tins, iron sheets) by mammals to reduce human-wildlife conflict**

Ten studies evaluated the effects of using loud noises to deter crop damage by mammals to reduce human-wildlife conflict. Three studies were in the USA, two were in Zimbabwe and Kenya and one each was in the UK, Namibia, and India.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (10 STUDIES)

Human-wildlife conflict (10 studies): Five of six studies (including two controlled, one replicated and two before-and-after studies), in the USA, Namibia, Kenya and India, found that loud noises activated when an animal was in the vicinity reduced or partially reduced crop damage or crop visits by white-tailed deer, black-tailed deer (when combined with using electric

shock collars) and elephants. The other study found that using loud noises (along with chili fences and chili smoke) did not reduce crop-raiding by African elephants. Three studies (including two controlled studies), in the UK and the USA, found that regularly sounding loud noises did not repel European rabbits or white-tailed deer. Two replicated studies, in Zimbabwe, found that, from among a range of deterrents, African elephants were repelled faster from crop fields when scared by firecrackers or by a combination of deterrents that included drums.

Assessment: likely to be beneficial (effectiveness 50%; certainty 55%; harms 0%).

<https://www.conservationevidence.com/actions/2460>

● Use loud noises to deter predation of livestock by mammals to reduce human-wildlife conflict

Three studies evaluated the effects of using loud noises to deter predation of livestock by mammals to reduce human-wildlife conflict. Two studies were in the USA and one was in Mexico.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (3 STUDIES)

Human-wildlife conflict (3 studies): Three replicated studies (including two controlled studies), in the USA and Mexico, found that loud noises at least temporarily deterred sheep predation or food consumption by coyotes and (combined with visual deterrents) deterred livestock predation by large predators.

Assessment: likely to be beneficial (effectiveness 60%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2435>

● Use predator scent to deter crop damage by mammals to reduce human-wildlife conflict

Three studies evaluated the effects of using predator scent to deter crop damage by mammals to reduce human-wildlife conflict. All three studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (3 STUDIES)

Human-wildlife conflict (3 studies): Two of three replicated, randomized,

controlled studies (including two before-and-after studies), in the USA, found that coyote scent reduced food consumption by mountain beavers and white-tailed deer. The third study found that it did not reduce trail use by white-tailed deer.

Assessment: likely to be beneficial (effectiveness 50%; certainty 47%; harms 0%).

<https://www.conservationevidence.com/actions/2505>

● **Use repellents that taste bad ('contact repellents') to deter crop or property damage by mammals to reduce human-wildlife conflict**

Twelve studies evaluated the effects of using repellents that taste bad ('contact repellents') to deter crop or property damage by mammals to reduce human-wildlife conflict. Nine studies were in the USA, two were in the UK and one was in Italy.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (12 STUDIES)

Human-wildlife conflict (12 studies): Five of 11 controlled studies (including 10 replicated studies), in the USA, Italy and the UK, of a range of contact repellents, found that they reduced herbivory or consumption of baits. The other six studies reported mixed results with at least some repellents at some concentrations deterring herbivory, sometimes for limited periods. A replicated, controlled study in the USA found that a repellent did not prevent chewing damage by coyotes.

Assessment: likely to be beneficial (effectiveness 50%; certainty 55%; harms 0%).

<https://www.conservationevidence.com/actions/2509>

● **Use scent to deter predation of livestock by mammals to reduce human-wildlife conflict**

Three studies evaluated the effects of using scent to deter predation of livestock by mammals to reduce human-wildlife conflict. Two studies were in the USA and one was in Botswana.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (3 STUDIES)

Human-wildlife conflict (3 studies): Two of three studies (including one

replicated, before-and-after study), in the USA and Botswana, found that applying scent marks from unfamiliar African wild dogs and grey wolves restricted movements of these species. The other study found that applying scent marks from coyotes did not restrict their movements.

Assessment: likely to be beneficial (effectiveness 50%; certainty 40%; harms 5%).

<https://www.conservationevidence.com/actions/2450>

● **Use target species distress calls or signals to deter crop damage by mammals to reduce human-wildlife conflict**

Five studies evaluated the effects of using target species distress calls or signals to deter crop damage by these species to reduce human-wildlife conflict. Two studies were in the USA and one each was in Namibia, Australia and Sri Lanka.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (5 STUDIES)

Human-wildlife conflict (5 studies): Two of five replicated studies (including four controlled studies), in the USA, Namibia, Australia and Sri Lanka, found that white-tailed deer and Asian elephants were deterred or repelled from areas by playing their respective distress calls. Two studies found that, in most cases, elephants and white-tailed deer were not deterred from entering or remaining at sites when distress calls were played. The fifth study found mixed results but, overall, eastern grey kangaroo foot-thumping noises did not increase numbers leaving a site.

Assessment: likely to be beneficial (effectiveness 40%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2488>

● **Use taste-aversion to reduce predation of livestock by mammals to deter human-wildlife conflict**

Nine studies evaluated the effects of using taste-aversion to reduce predation of livestock by mammals to deter human-wildlife conflict. Six studies were in the USA, two were in Canada and one was at an unnamed location.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (9 STUDIES)

Human-wildlife conflict (9 studies): Three of seven replicated studies (including

three controlled studies), in the USA, Canada and at an unnamed location, found that coyotes killed fewer sheep, rabbits or turkeys after taste-aversion treatment. The other four studies found that taste-aversion treatment did not reduce killing by coyotes of chickens, sheep or rabbits. A replicated, before-and-after study in the USA found that taste-aversion treatment reduced egg predation by mammalian predators whilst a replicated, controlled, paired sites study in the USA found no such effect.

Assessment: likely to be beneficial (effectiveness 40%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2429>

Trade-off between benefit and harms

● **Translocate crop raiders away from crops (e.g. elephants) to reduce human-wildlife conflict**

Two studies evaluated the effects on mammals of translocating crop-raiding animals away from crops to reduce human-wildlife conflict. One study was in Kenya and one was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A controlled study in Kenya found that translocated crop-raiding African elephants had a lower survival rate after release than did non-translocated elephants at the same site.

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A study in the USA found that most American black bears translocated from sites of crop damage were not subsequently recaptured at sites of crop damage.

Assessment: trade-off between benefit and harms (effectiveness 40%; certainty 40%; harms 37%).

<https://www.conservationevidence.com/actions/2485>

● **Translocate predators away from livestock to reduce human-wildlife conflict**

Eleven studies evaluated the effects on mammals of translocating predators away from livestock to reduce human-wildlife conflict. Four studies were in the USA two were in Botswana, one each was in Canada, Zimbabwe and Namibia, one was in Venezuela and Brazil and one covered multiple locations in North and Central America and Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (8 STUDIES)

Reproductive success (2 studies): Two studies, in Zimbabwe and Namibia, found that predators translocated away from livestock bred in the wild after release.

Survival (8 studies): Four of eight studies (including three replicated studies and a systematic review), in the USA, Canada, Zimbabwe, South America, Botswana and Namibia, found that translocating predators reduced their survival or that most did not survive more than 6–12 months after release. Three studies found that translocated predators had similar survival to that of established animals or persisted in the wild and one study could not determine the effect of translocation on survival.

BEHAVIOUR (0 STUDIES)

OTHER (6 STUDIES)

Human-wildlife conflict (6 studies): Four of six studies (including a review and a systematic review), in the USA, South America and in North and Central America and Africa, found that some translocated predators continued to predate livestock or returned to their capture sites. One study found that translocated predators were not subsequently involved in livestock predation and one study could not determine the effect of translocation on livestock predation.

Assessment: trade-off between benefit and harms (effectiveness 40%; certainty 56%; harms 30%).

<https://www.conservationevidence.com/actions/2436>

Unknown effectiveness

- **Deter predation of livestock by herding livestock using adults instead of children to reduce human-wildlife conflict**

One study evaluated the effects on predatory mammal activities of herding livestock using adults instead of children to reduce human-wildlife conflict. This study was in Cameroon.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A site comparison study in Cameroon found that using adults to herd livestock reduced losses through predation

relative to that of livestock herded solely by children.

Assessment: unknown effectiveness (effectiveness 70%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2445>

● **Deter predation of livestock by mammals by having people close by to reduce human-wildlife conflict**

One study evaluated the effects of deterring predation of livestock by mammals by having people close by to reduce human-wildlife conflict. This study was in Kenya.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): One study in Kenya recorded fewer attacks by predators on livestock in bomas when people were also present but the presence of people did not reduce predator attacks on grazing herds.

Assessment: unknown effectiveness (effectiveness 50%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2444>

● **Dispose of livestock carcasses to deter predation of livestock by mammals to reduce human-wildlife conflict**

One study evaluated the effects of disposing of livestock carcasses to deter predation of livestock by mammals to reduce human-wildlife conflict. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): One site comparison study in the USA found that burying or removing sheep carcasses reduced predation on livestock by coyotes, but burning carcasses did not alter livestock predation rates.

Assessment: unknown effectiveness (effectiveness 60%; certainty 35%; harms 0%).

<https://www.conservationevidence.com/actions/2432>

● **Drive wild animals away using domestic animals of the same species to reduce human-wildlife conflict**

One study evaluated the effects of using domestic animals to drive away wild mammals to reduce human-wildlife conflict. This study was in India.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): One study in India found that using domestic elephants to drive wild Asian elephants away from villages did not reduce the probability of elephants damaging crops.

Assessment: unknown effectiveness (effectiveness 0%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2513>

● **Fit livestock with protective collars to reduce risk of predation by mammals to reduce human-wildlife conflict**

One study evaluated the effects of fitting livestock with protective collars to reduce human-wildlife conflict on rates of livestock killings by predators. This study was in South Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated, before-and-after study in South Africa found that livestock protection collars reduced predation on livestock by carnivores.

Assessment: unknown effectiveness (effectiveness 60%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2448>

● **Install automatically closing gates at field entrances to prevent mammals entering to reduce human-wildlife conflict**

One study evaluated the effects on mammal movements of installing automatically closing gates at field entrances to reduce human-wildlife conflict. This study was in USA.

KEY COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated, controlled study, in the USA

found that vehicle-activated bump gates prevented white-tailed deer from entering enclosures.

Assessment: unknown effectiveness (effectiveness 70%; certainty 38%; harms 0%).

<https://www.conservationevidence.com/actions/2441>

● **Provide diversionary feeding to reduce predation of livestock by mammals to reduce human-wildlife conflict**

Two studies evaluated the effects of providing diversionary feeding to reduce predation of livestock by mammals to reduce human-wildlife conflict. One study was in the USA and one was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Reproductive success (1 study): A controlled study in the USA found that diversionary feeding of predators did not increase overall nest success rates for ducks.

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human-wildlife conflict (2 studies): One of two studies (one controlled, one before-and-after study) in the USA and Canada found that diversionary feeding reduced striped skunk predation on duck nests. The other study found that diversionary feeding of grizzly bears did not reduce predation on livestock.

Assessment: unknown effectiveness (effectiveness 21%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2437>

● **Relocate local pastoralist communities to reduce human-wildlife conflict**

One study evaluated the effects on mammals of relocating local pastoralists to reduce human-wildlife conflict. This study was in India.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A study in India found that after most pastoralists were relocated outside of an area, Asiatic lion numbers increased.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 60%; certainty 10%; harms 10%).

<https://www.conservationevidence.com/actions/2413>

● **Use dogs to guard crops to reduce human-wildlife conflict**

One study evaluated the effects on mammals of using dogs to guard crops to reduce human-wildlife conflict. This study was in Zimbabwe.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated study in Zimbabwe found that people with dogs took longer to repel African elephants from crops compared to scaring them by using combinations of people, dogs, slingshots, drums, burning sticks, large fires and spraying with capsicum.

Assessment: unknown effectiveness (effectiveness 27%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2512>

● **Use drones to deter crop damage by mammals to reduce human-wildlife conflict**

One study evaluated the effects on mammals of using drones to deter crop damage by mammals to reduce human-wildlife conflict. This study was in Tanzania.

KEY COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated study in Tanzania found that drones repelled African savanna elephants from crops within one minute.

Assessment: unknown effectiveness (effectiveness 72%; certainty 35%; harms 0%).

<https://www.conservationevidence.com/actions/2481>

● **Use light/lasers to deter crop damage by mammals to reduce human-wildlife conflict**

Two studies evaluated the effects of using light or lasers to deter crop damage by mammals to reduce human-wildlife conflict. Both studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human-wildlife conflict (2 studies): A replicated, randomized, controlled study in the USA found that red lasers did not disperse white-tailed deer from fields at night whilst a study in India found that spotlights directed at the eyes of Asian elephants did reduce the probability of crop damage.

Assessment: unknown effectiveness (effectiveness 40%; certainty 23%; harms 0%).

<https://www.conservationevidence.com/actions/2496>

● **Use negative stimuli to deter consumption of livestock feed by mammals to reduce human-wildlife conflict**

One study evaluated the effects of using negative stimuli to deter consumption of livestock feed by mammals to reduce human-wildlife conflict. This study was in the USA.

KEY COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated, controlled study in the USA found that white-tailed deer presence at cattle feeders was usually reduced by a device that produced a negative stimulus.

Assessment: unknown effectiveness (effectiveness 50%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2486>

● **Use noise aversive conditioning to deter crop damage by mammals to reduce human-wildlife conflict**

One study evaluated the effects of using noise aversive conditioning to deter crop damage by mammals to reduce human-wildlife conflict. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated, controlled study in USA found that noise aversive conditioning reduced bait consumption by white-tailed deer.

Assessment: unknown effectiveness (effectiveness 55%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2461>

● **Use repellents that smell bad ('area repellents') to deter crop or property damage by mammals to reduce human-wildlife conflict**

One study evaluated the effects of using repellents that smell bad ('area repellents') to deter crop or property damage by mammals to reduce human-wildlife conflict. This study was in the UK.

KEY COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A randomized, replicated, controlled study in the UK found that a repellent reduced use of treated areas by moles. *Assessment: unknown effectiveness (effectiveness 60%; certainty 21%; harms 0%).*

<https://www.conservationevidence.com/actions/2511>

● **Use target species scent to deter crop damage by mammals to reduce human-wildlife conflict**

One study evaluated the effects on mammals of using target species scent to deter crop damage to reduce human-wildlife conflict. This study was in South Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated, controlled study in South Africa found that African elephants were not deterred from feeding by the presence of secretions from elephant temporal glands.

Assessment: unknown effectiveness (effectiveness 0%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2506>

● **Use ultrasonic noises to deter crop damage by mammals to reduce human-wildlife conflict**

One study evaluated the effects of using ultrasonic noises to deter crop damage by mammals to reduce human-wildlife conflict. This study was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated, controlled, paired sites study in Australia found that ultrasonic devices did not repel eastern gray kangaroos. *Assessment: unknown effectiveness (effectiveness 0%; certainty 20%; harms 0%).*

<https://www.conservationevidence.com/actions/2479>

● **Use visual deterrents (e.g. scarecrows) to deter predation of livestock by mammals to reduce human-wildlife conflict**

Two studies evaluated the effects of using visual deterrents, such as scarecrows, to deter predation of livestock by mammals to reduce human-wildlife conflict. One study was in Kenya and one was in Mexico.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human-wildlife conflict (2 studies): A study in Kenya recorded more livestock predation at bomas with scarecrows than those without scarecrows whereas a replicated, controlled study in Mexico found that a combination of visual and sound deterrents reduced livestock predation.

Assessment: unknown effectiveness (effectiveness 30%; certainty 30%; harms 10%).

<https://www.conservationevidence.com/actions/2427>

● **Use 'shock collars' to deter crop damage by mammals to reduce human-wildlife conflict**

One study evaluated the effects on mammals of using 'shock collars' to deter crop damage to reduce human-wildlife conflict. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated, controlled study in the USA found that electric shock collars (combined with loud noise) reduced damage caused by black-tailed deer to tree seedlings.

Assessment: unknown effectiveness (effectiveness 60%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2508>

Unlikely to be beneficial

● Use lights and sound to deter crop damage by mammals to reduce human-wildlife conflict

Two studies evaluated the effects of using both lights and sound to deter crop damage by mammals to reduce human-wildlife conflict. Both studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human-wildlife conflict (2 studies): Two replicated paired sites, controlled studies (one also randomized), in the USA, found that frightening devices, emitting lights and sound, did not reduce crop intrusions by white-tailed deer or food consumption by elk and mule deer.

Assessment: unlikely to be beneficial (effectiveness 20%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2456>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Establish deviation ponds in fish farms to reduce predation of fish stock by mammals to reduce human-wildlife conflict
- Grow unattractive crop in buffer zone around crops (e.g. chili peppers) to reduce human-wildlife conflict
- Play predator calls to deter crop damage by mammals to reduce human-wildlife conflict
- Use fencing/netting to reduce predation of fish stock by mammals to reduce human-wildlife conflict
- Use mobile phone communications to warn farmers of problematic mammals (e.g. elephants)
- Use pheromones to deter crop damage by mammals to reduce human-wildlife conflict
- Use pheromones to deter predation of livestock by mammals to reduce human-wildlife conflict
- Use scarecrows to deter crop damage by mammals to reduce human-wildlife conflict



- Use tree nets to deter wild mammals from fruit crops to reduce human-wildlife conflict
- Use watchmen to deter crop damage by mammals to reduce human-wildlife conflict.

15.3 Threat: Energy production and mining

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for energy production and mining?	
Likely to be beneficial	<ul style="list-style-type: none"> • Restore former mining sites
Unknown effectiveness	<ul style="list-style-type: none"> • Translocate mammals away from sites of proposed energy developments • Use repellents to reduce cable gnawing
No evidence found (no assessment)	<ul style="list-style-type: none"> • Use electric fencing to deter mammals from energy installations or mines

Likely to be beneficial

● Restore former mining sites

Twelve studies evaluated the effects of restoring former mining sites on mammals. Eleven studies were in Australia and one was in the USA.

COMMUNITY RESPONSE (8 STUDIES)

Species richness (8 studies): A review in Australia found that seven of 11 studies indicated that rehabilitated areas had lower mammal species richness compared to unmined areas. Four of five replicated, site comparison studies, in Australia, found that mammal species richness was similar in restored mine areas compared to unmined areas or higher in restored areas (but similar when considering only native species). One study found that species richness was lower in restored compared to in unmined areas. A replicated, controlled study in Australia found that thinning trees and burning vegetation

as part of mine restoration did not increase small mammal species richness. A replicated, site comparison study in Australia found that restored mine areas were recolonized by a range of mammal species within 10 years.

POPULATION RESPONSE (5 STUDIES)

Abundance (5 studies): A review of rehabilitated mine sites in Australia found that only two of eight studies indicated that rehabilitated areas had equal or higher mammal densities compared to those in unmined areas. One of three replicated, site comparison studies, in the USA and Australia, found that small mammal density was similar on restored mines compared to on unmined land. One study found that for three of four species (including all three native species studied) abundance was lower in restored compared to unmined sites and one study found mixed results, including that abundances of two out of three focal native species were lower in restored compared to unmined sites. A replicated, controlled study in Australia found that thinning trees and burning vegetation as part of mine restoration did not increase small mammal abundance.

BEHAVIOUR (2 STUDIES)

Use (2 studies): A replicated, site comparison study in Australia found that most restored former mine areas were not used by koalas while another replicated site comparison study in Australia found quokka activity to be similar in revegetated mined sites compared to in unmined forest.

OTHER (1 STUDY)

Genetic diversity (1 study): A site comparison study in Australia found that in forest on restored mine areas, genetic diversity of yellow-footed antechinus was similar to that in unmined forest.

Assessment: likely to be beneficial (effectiveness 40%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2490>

Unknown effectiveness

● Translocate mammals away from sites of proposed energy developments

Two studies evaluated the effects of translocating mammals away from sites of proposed energy developments. One study was in Brazil and one was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (2 STUDIES)

Behaviour change (2 studies): A study in Brazil found that lesser anteaters translocated away from a hydroelectric development site remained close to release sites while a study in Australia found that at least one out of eight chuditchs translocated from a site to be mined returned to its site of capture. *Assessment: unknown effectiveness (effectiveness 50%; certainty 23%; harms 5%).*

<https://www.conservationevidence.com/actions/2517>

● Use repellents to reduce cable gnawing

One study evaluated the effects of using repellents to reduce cable gnawing. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A randomized, replicated, controlled study in the USA found that repellents only deterred cable gnawing by northern pocket gophers when encased in shrink-tubing.

Assessment: unknown effectiveness (effectiveness 40%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2502>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Use electric fencing to deter mammals from energy installations or mines.

15.4 Threat: Transportation and service corridors

15.4.1 Roads and railroads

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for roads and railroads?	
Beneficial	<ul style="list-style-type: none"> • Install barrier fencing along roads • Install barrier fencing and underpasses along roads • Install overpasses over roads/railways • Install rope bridges between canopies
Likely to be beneficial	<ul style="list-style-type: none"> • Install fences around existing culverts or underpasses under roads/railways • Install ledges in culverts under roads/railways • Install one-way gates or other structures to allow wildlife to leave roadways • Install pole crossings for gliders/flying squirrels • Install signage to warn motorists about wildlife presence • Install tunnels/culverts/underpass under railways • Install tunnels/culverts/underpass under roads • Install wildlife exclusion grates/cattle grids • Install wildlife warning reflectors along roads • Modify vegetation along railways to reduce collisions by reducing attractiveness to mammals • Provide food/salt lick to divert mammals from roads or railways

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for roads and railroads?	
Unknown effectiveness	<ul style="list-style-type: none"> • Close roads in defined seasons • Dig trenches around culverts under roads/ railways • Install acoustic wildlife warnings along roads • Install barrier fencing along railways • Install traffic calming structures to reduce speeds • Install wildlife crosswalks • Modify culverts to make them more accessible to mammals • Modify the roadside environment to reduce collisions by reducing attractiveness of road verges to mammals • Reduce legal speed limit • Use road lighting to reduce vehicle collisions with mammals
Unlikely to be beneficial	<ul style="list-style-type: none"> • Fit vehicles with ultrasonic warning devices • Use chemical repellents along roads or railways
No evidence found (no assessment)	<ul style="list-style-type: none"> • Modify vegetation along roads to reduce collisions with mammals by enhancing visibility for drivers • Remove roadkill regularly to reduce kill rate of predators/scavengers • Retain/maintain road verges as small mammal habitat • Use alternative de-icers on roads • Use reflective collars or paint on mammals to reduce collisions with road vehicles • Use wildlife decoy to reduce vehicle collisions with mammals

Beneficial

● **Install barrier fencing along roads**

Twelve studies evaluated the effects on mammals of installing barrier fencing along roads. Eight studies were in the USA, one each was in Canada, Germany and Brazil and one spanned the USA, Canada and Sweden.



COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (9 STUDIES)

Survival (9 studies): Three controlled studies, in the USA, Germany and Brazil, found that roadside fencing or equivalent barrier systems reduced the numbers of mammals, including wildcats and coypu, killed by vehicles on roads. Two before-and-after studies, in the USA, found that roadside fencing with one-way gates to allow escape from the road, reduced the number of collisions between vehicles and deer. A study in the USA found that a 2.7-m-high fence did not reduce road-kills of white-tailed deer compared to a 2.2-m-high fence. A controlled, before-and-after study in the USA found that barrier fencing with designated crossing points did not significantly reduce road deaths of mule deer. A replicated, controlled, before-and-after study in Canada found that electric fences, (along with an underpass beneath one highway), reduced moose-vehicle collisions. A review of fencing studies from USA, Canada and Sweden, found that longer fencing along roadsides led to a greater reduction of collisions between large mammals and cars than did shorter fence sections.

BEHAVIOUR (5 STUDIES)

Behaviour change (5 studies): A controlled, before-and-after study in the USA found that 2.3-m-high fencing in good condition prevented most white-tailed deer accessing a highway. A replicated, controlled, before-and-after study in Canada found that electric fences reduced moose access to highways. Three studies (two replicated), in the USA, found that higher fences (2.4–2.7 m) prevented more white-tailed deer from entering highways than did fences that were 2.2 m high, 1.2 m high with outriggers or 1.2–1.8 m high.

Assessment: beneficial (effectiveness 70%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2567>

● **Install barrier fencing and underpasses along roads**

Fifty-five studies evaluated the effects on mammals of installing barrier fencing and underpasses along roads. Twenty-seven were in the USA, nine were in Canada, seven were in Australia, two each were in Spain, Portugal, the UK and Sweden, one each was in Denmark, Germany and Croatia and one was a review covering Australia, Europe and North America.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (15 STUDIES)

Survival (15 studies): Eleven of 15 studies (including 12 before-and-after studies and two site comparisons), in the USA, Australia, Sweden and Canada, found that installing underpasses and associated roadside barrier fencing

reduced collisions between vehicles and mammals. Three studies found that the roadkill rate was not reduced and one study found that vehicle-mammal collisions continued to occur after installation.

BEHAVIOUR (52 STUDIES)

Use (52 studies): Seventeen of 18 studies (including 10 before-and-after studies) in the USA, Canada and Sweden, which reported exclusively on ungulates, found that underpasses installed along with roadside barrier fencing were used by a range of ungulate species. These were mule deer, mountain goat, pronghorn, white-tailed deer, elk, moose and Florida Key deer. The other study found that underpasses were not used by moose whilst one of the studies that did report use by ungulates further reported that they were not used by white-tailed deer. Further observations from these studies included that elk preferred more open, shorter underpasses to those that were enclosed or longer, underpass use was not affected by traffic levels and that mule deer used underpasses less than they used overpasses. Thirty-four studies (including four before-and-after studies, seven replicated studies, three site comparisons and two reviews), in the USA, Canada, Australia, Spain, Portugal, the UK, Denmark, Germany, Croatia and across multiple continents, that either studied mammals other than ungulates or multiple species including ungulates, found that underpasses in areas with roadside fencing were used by mammals. Among these studies, one found that small culverts were used by mice and voles more than were larger underpasses, one found that bandicoots used underpasses less after they were lengthened and one found that culverts were used by grizzly bears less often than were overpasses.

Assessment: beneficial (effectiveness 72%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2571>

● **Install overpasses over roads/railways**

Twenty-two studies evaluated the effects on mammals of installing overpasses over roads or railways. Seven studies were in Canada, three were in Spain, three were in Australia, two were in Sweden, one each was in the Netherlands, Germany, Croatia and the USA, and three (including two reviews) were conducted across multiple countries.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (4 STUDIES)

Survival (4 studies): Four studies (including three before-and-after studies), in Canada, Sweden and Australia, found that overpasses (in combination with roadside fencing) reduced collisions between vehicles and mammals. In



two of these studies, data from overpasses and underpasses were combined for analysis.

BEHAVIOUR (21 STUDIES)

Use (21 studies): Nineteen studies, in North America, Europe and Australia, found that overpasses were used by mammals. A wide range of mammals was reported using overpasses, including rodents and shrews, rabbits and hares, carnivores, ungulates, bears, marsupials and short-beaked echidna. A review of crossing structures in Australia, Europe and North America found that overpasses were used by a range of mammals, particularly larger mammal species. A global review of crossing structures (including overpasses) found that all studies reported that the majority of crossings were used by wildlife.

Assessment: beneficial (effectiveness 90%; certainty 80%; harms 0%).

<https://www.conservationevidence.com/actions/2526>

● Install rope bridges between canopies

Ten studies evaluated the effects on mammals of install rope bridges between canopies. Eight studies were in Australia, one was in Brazil and one in Peru.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A study in Australia found that arboreal marsupials using rope bridges did not suffer high predation rates when doing so.

BEHAVIOUR (9 STUDIES)

Use (9 studies): Nine studies (including three replicated studies and a site comparison), in Australia, Brazil and Peru found that rope bridges were used by a range of mammals. Seven of these studies found between three and 25 species using rope bridges, one found that that they were used by squirrel gliders and one that they were used by mountain brushtail possums and common ringtail possums but not by koalas and squirrel gliders. One of the studies found that crossing rates were higher over the canopy bridges than at ground level.

Assessment: beneficial (effectiveness 80%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2556>

Likely to be beneficial

● Install fences around existing culverts or underpasses under roads/railways

Four studies evaluated the effects on mammals of installing fences around

existing culverts under roads/railways. Two studies were in the USA one was in Portugal and one was in South Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Survival (3 studies): Two out of three before-and-after studies (including a controlled and a site comparison study), in the USA, Portugal and South Africa, found that installing or enhancing roadside fencing alongside existing culverts reduced mammal road mortality whilst one study found that such fences did not alter mammal road mortality.

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated, randomized, controlled, before-and-after study in the USA found that fences installed to funnel animals to existing culverts did not increase culvert use by bobcats.

Assessment: likely to be beneficial (effectiveness 50%; certainty 46%; harms 0%).

<https://www.conservationevidence.com/actions/2525>

● **Install ledges in culverts under roads/railways**

Three studies evaluated the effects on mammals of installing ledges in culverts under roads or railways. Two studies were in the USA and one was in Portugal.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (3 STUDIES)

Use (3 studies): A replicated, controlled study in Portugal found that under-road culverts with ledges were used more than culverts without ledges by two of five mammal species. A before-and-after study in the USA found that installing ledges within under-road culverts did not increase the number or diversity of small mammal species crossing through them, and only one of six species used ledges. A study in the USA found that ledges in under-road culverts were used by nine of 12 small mammal species and ledges with access ramps were used more often than those without.

Assessment: likely to be beneficial (effectiveness 60%; certainty 45%; harms 0%).

<https://www.conservationevidence.com/actions/2523>

● **Install one-way gates or other structures to allow wildlife to leave roadways**

Seven studies evaluated the effects on mammals of installing one-way gates or other structures to allow wildlife to leave roadways. All seven studies were in the USA.



COMMUNITY RESPONSE (5 STUDIES)

Survival (5 studies): Two before-and-after studies (one replicated), in the USA, found that barrier fencing with one-way gates reduced deer-vehicle collisions. One of two studies (one before-and-after and one replicated, controlled), in the USA, found that barrier fencing with escape gates along roads with one or more underpasses reduced moose-vehicle collisions, whilst the other found no reduction in total mammal road casualty rates. A replicated, controlled, before-and-after study in USA found that earth escape ramps reduced mammal road mortalities.

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (4 STUDIES)

Use (4 studies): One of two studies (one replicated) in the USA, found that one-way gates allowed mule deer to escape when trapped along highways with barrier fencing, whilst the other found that a small proportion used one-way gates. A replicated, controlled, before-and-after study in the USA found that earth escape ramps were used more often than were one-way escape gates to enable deer to escape highways with barrier fencing. A replicated, controlled study in the USA found that barrier fencing with escape gates and underpasses facilitated road crossings by a range of mammals.

Assessment: likely to be beneficial (effectiveness 60%; certainty 57%; harms 0%).

<https://www.conservationevidence.com/actions/2558>

● Install pole crossings for gliders/flying squirrels

Seven studies evaluated the effects on gliders/flying squirrels of installing pole crossings. Six studies were in Australia and one was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A study in Australia found that arboreal marsupials using artificial road crossing structures did not suffer high predation rates when doing so.

BEHAVIOUR (6 STUDIES)

Use (6 studies): Six studies (five replicated), in Australia and the USA, found that poles were used for crossing roads by squirrel gliders, sugar gliders and Carolina northern flying squirrels.

Assessment: likely to be beneficial (effectiveness 80%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2546>

● **Install signage to warn motorists about wildlife presence**

Six studies evaluated the effects on mammals of installing signage to warn motorists about wildlife presence. Four studies were in the USA one was in Australia and one was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (6 STUDIES)

Abundance (1 study): A before-and-after study in Australia found that when wildlife signs were installed along with speed restrictions, rumble strips, reflective wildlife deterrents, wildlife escape ramps and an educational pamphlet, a small population of eastern quoll re-established in the area.

Survival (6 studies): Three of five studies (including four controlled and three before-and-after studies), in the USA and Canada, found that warning signs did not reduce collisions between vehicles and deer. The other two studies found that warning signs did reduce collisions between vehicles and deer. A before-and-after study in Australia found that wildlife signs along with speed restrictions, rumble strips, reflective wildlife deterrents, wildlife escape ramps and an educational pamphlet, reduced collisions between vehicles and Tasmanian devils but not eastern quolls.

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human behaviour change (2 studies): Two controlled studies (one also replicated, before-and-after), in the USA, found that signs warning of animals on the road reduced vehicles speeds.

Assessment: likely to be beneficial (effectiveness 50%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2608>

● **Install tunnels/culverts/underpass under railways**

Six studies evaluated the effects on mammals of installing tunnels, culverts or underpass under railways. Two studies were in Spain, one was in each of Australia, Canada and the Netherlands and one reviewed literature from a range of countries.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A review found that most studies recorded no evidence of predation in or around passages under railways or roads of mammals using those passages.

BEHAVIOUR (5 STUDIES)

Use (5 studies): Five studies, in Spain, Australia, Canada and the Netherlands, found that tunnels, culverts and underpasses beneath railways were used

by a range of mammals including rodents, rabbits and hares, carnivores, marsupials, deer and bears. One of these studies found that existing culverts were used more than were specifically designed wildlife tunnels.

Assessment: likely to be beneficial (effectiveness 80%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2519>

● **Install tunnels/culverts/underpass under roads**

Twenty-five studies evaluated the effects on mammals of installing tunnels, culverts or underpass under roads. Eight studies were in the USA, four were in Australia, four were in Canada, two were in Spain, one each was in Germany, the Netherlands and South Korea and three were reviews with wide geographic coverage.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Survival (3 studies): A study in South Korea found that road sections with higher underpass density did not have fewer wildlife-vehicle collisions. A review found that most studies recorded no evidence of predation of mammals using crossings under roads. A controlled, before-and-after, site comparison study in Australia found that overwinter survival of mountain pygmy-possums increased after an artificial rocky corridor, which included two underpasses, was installed.

BEHAVIOUR (23 STUDIES)

Use (23 studies): Seventeen of 20 studies (including seven replicated studies and two reviews), in the USA, Canada, Australia, Spain, the Netherlands, and across multiple continents, found that crossing structures beneath roads were used by mammals whilst two studies found mixed results depending on species and one study found that culverts were rarely used as crossings by mammals. One of the studies found that crossing structures were used by two of four species more than expected compared to their movements through adjacent habitats. A controlled, before-and-after, site comparison study in Australia found that an artificial rocky corridor, which included two underpasses, was used by mountain pygmy-possums. A replicated study in Germany found that use of tunnels by fallow deer was affected by tunnel colour and design. A study in the USA found that a range of mammals used culverts, including those with shelves fastened to the sides.

Behaviour change (1 study): A controlled, before-and-after, site comparison study in Australia found that after an artificial rocky corridor, which included two underpasses, was installed, dispersal of mountain pygmy-possums increased.

Assessment: likely to be beneficial (effectiveness 62%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2514>

● **Install wildlife exclusion grates/cattle grids**

Three studies evaluated the effects on mammals of installing wildlife exclusion grates or cattle grids. All three studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (3 STUDIES)

Behaviour change (3 studies): Two of three studies (including two replicated, before-and-after studies), in the USA, found that steel grates largely prevented crossings by deer whilst two found that they did not prevent crossings by deer and elk or black bears. In one of the studies, only one of three designs prevented crossings.

Assessment: likely to be beneficial (effectiveness 47%; certainty 41%; harms 0%).

<https://www.conservationevidence.com/actions/2594>

● **Install wildlife warning reflectors along roads**

Fifteen studies evaluated the effects on mammals of installing wildlife warning reflectors along roads. Nine studies were in the USA, three were in Australia, two were in Germany and one was in Denmark.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (10 STUDIES)

Abundance (1 study): A before-and-after study in Australia found that when warning reflectors were installed (along with speed restrictions, reflective wildlife signs, rumble strips, wildlife escape ramps and an educational pamphlet) a small population of eastern quoll re-established in the area.

Survival (10 studies): Five of eight controlled or before-and-after studies in the USA and Germany found that wildlife warning reflectors did not reduce collisions between vehicles and deer. Two studies found that vehicle-deer collisions were reduced by reflectors and one found that collisions were reduced in rural areas but increased in suburban areas. A before-and-after study in Australia found that when warning reflectors were installed (along with speed restrictions, reflective wildlife signs, rumble strips, wildlife escape ramps and an educational pamphlet) vehicle collisions with Tasmanian devils, but not eastern quolls, decreased. A review of two studies in Australia found mixed responses of mammal road deaths to wildlife warning reflectors.

BEHAVIOUR (5 STUDIES)



Behaviour change (5 studies): Three of four studies (including three controlled studies), in the USA, Denmark and Germany, found that wildlife warning reflectors did not cause deer to behave in ways that made collisions with vehicles less likely (such as by avoiding crossing roads). The other study found that deer initially responded to wildlife reflectors with alarm and flight but then became habituated. A replicated, controlled study in Australia found that one of four reflector model/colour combinations increased fleeing behaviour of bush wallabies when lights approached. The other combinations had no effect and none of the combinations affected red kangaroos.

Assessment: likely to be beneficial (effectiveness 40%; certainty 60%; harms 5%).

<https://www.conservationevidence.com/actions/2591>

● **Modify vegetation along railways to reduce collisions by reducing attractiveness to mammals**

Two studies evaluated the effects of modifying vegetation along railways to reduce collisions by reducing attractiveness to wildlife. Both studies were in Norway.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Survival (2 studies): Two site comparison studies in Norway found that clearing vegetation from alongside railways reduced moose-train collisions.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 70%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2603>

● **Provide food/salt lick to divert mammals from roads or railways**

Three studies evaluated the effects of providing food or salt licks to divert mammals from roads. One study was in the USA, one was in Norway and one was a review of studies from across North America and Europe.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Survival (2 studies): A replicated, controlled study in the USA found that intercept feeding reduced mule deer road deaths along two of three highways in one of two years. A replicated, site comparison study in Norway found that intercept feeding reduced moose collisions with trains.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A review of feeding wild ungulates in North

America, and Europe found that feeding diverted ungulates away from roads in one of three studies.

Assessment: likely to be beneficial (effectiveness 60%; certainty 52%; harms 0%).

<https://www.conservationevidence.com/actions/2617>

Unknown effectiveness

● Close roads in defined seasons

One study evaluated the effects on mammals of closing roads in defined seasons. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A site comparison study in the USA found that closing roads to traffic during the hunting season increased use of those areas by mule deer.

Assessment: unknown effectiveness (effectiveness 60%; certainty 15%; harms 0%).

<https://www.conservationevidence.com/actions/2626>

● Dig trenches around culverts under roads/railways

One study evaluated the effects on mammals of digging trenches around culverts under roads and/or railways. This study was in South Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A replicated, randomized, controlled, before-and-after study in South Africa found that digging trenches alongside culverts did not reduce mammal mortality on roads.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 10%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2524>

● Install acoustic wildlife warnings along roads

Two studies evaluated the effects on mammals of installing acoustic wildlife warnings along roads. One study was in Denmark and one was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (2 STUDIES)

Behaviour change (2 studies): A before-and-after study in Denmark found that sound from acoustic road markings did not alter fallow deer behaviour.



A controlled study in Australia found that Roo-Guard® sound emitters did not deter tamar wallabies from food and so were not considered suitable for keeping them off roads.

Assessment: unknown effectiveness (effectiveness 5%; certainty 37%; harms 0%).

<https://www.conservationevidence.com/actions/2592>

● **Install barrier fencing along railways**

One study evaluated the effects on mammals of installing barrier fencing along railways. This study was in Norway.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A before-and-after study in Norway found that fencing eliminated moose collisions with trains, except at the fence end.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 80%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2590>

● **Install traffic calming structures to reduce speeds**

One study evaluated the effects on mammals of installing traffic calming structures to reduce speeds. This study was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A before-and-after study in Australia found that following installation of barriers to create a single lane, rumble strips, reflective wildlife signs, reflective wildlife deterrents, wildlife escape ramps and production of an educational pamphlet, a small population of eastern quoll population re-established in the area.

Survival (1 study): A before-and-after study in Australia found that following installation of barriers to create a single lane, rumble strips, reflective wildlife signs, reflective wildlife deterrents, wildlife escape ramps and production of an educational pamphlet, vehicle collisions with Tasmanian devils, but not eastern quolls decreased.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 60%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2598>

● **Install wildlife crosswalks**

One study evaluated the effects on mammals of installing wildlife crosswalks.

This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A replicated, before-and-after, site comparison study in the USA found that designated crossing points with barrier fencing did not significantly reduce road deaths of mule deer.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 0%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2593>

● **Modify culverts to make them more accessible to mammals**

One study evaluated the effects of modifying culverts to make them more accessible to mammals. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated, site comparison study in the USA found that modified culverts (with a dry walkway, open-air central section and enlarged entrances) were used more by bobcats to make crossings than were unmodified culverts.

Assessment: unknown effectiveness (effectiveness 70%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2522>

● **Modify the roadside environment to reduce collisions by reducing attractiveness of road verges to mammals**

One study evaluated the effects of modifying the roadside environment to reduce collisions by reducing attractiveness of road verges to mammals. This study was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

(1 study): A replicated, before-and-after, site comparison study in Canada found that draining roadside salt pools and filling them with rocks reduced the number and duration of moose visits.

Assessment: unknown effectiveness (effectiveness 60%; certainty 25%; harms 0%).

<https://www.conservationevidence.com/actions/2600>



● Reduce legal speed limit

One study evaluated the effects on mammals of reducing the legal speed limit. This study was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A controlled, before-and-after study in Canada found that speed limit reductions and enforcement did not reduce vehicle collisions with bighorn sheep or elk.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 5%; certainty 27%; harms 0%).

<https://www.conservationevidence.com/actions/2596>

● Use road lighting to reduce vehicle collisions with mammals

Two studies evaluated the effects on mammals of using road lighting to reduce vehicle collisions with mammals. Both studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Survival (2 studies): One of two studies (one controlled and one before-and-after), in the USA, found that road lighting reduced vehicle collisions with moose. The other study found that road lighting did not reduce vehicle collisions with mule deer.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 50%; certainty 30%; harms 2%).

<https://www.conservationevidence.com/actions/2614>

Unlikely to be beneficial

● Fit vehicles with ultrasonic warning devices

Three studies evaluated the effects on mammals of fitting vehicles with ultrasonic warning devices. Two studies were in the USA and one was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A replicated, controlled study in Australia found that Shu Roo warning whistles did not reduce animal-vehicle collisions for eastern grey kangaroos or red kangaroos

BEHAVIOUR (3 STUDIES)

Behaviour change (3 studies): Three controlled studies (two replicated), in the USA and Australia, found that ultrasonic warning devices did not deter mule deer, eastern grey kangaroos, red kangaroos or white-tailed deer from roads. *Assessment: unlikely to be beneficial (effectiveness 0%; certainty 55%; harms 0%).*

<https://www.conservationevidence.com/actions/2606>

● Use chemical repellents along roads or railways

Five studies evaluated the effects on mammals of using chemical repellents along roads or railways. Two studies were in Canada and one each was in Germany, Norway and Denmark.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Survival (2 studies): Two studies (one before-and-after, one site comparison), in Germany and Norway, found that chemical-based repellents did not reduce collisions between ungulates and road vehicles or trains.

BEHAVIOUR (4 STUDIES)

Behaviour change (4 studies): Two of four studies (including three replicated, controlled studies), in Germany, Canada, and Denmark, found that chemical repellents, trialled for potential to deter animals from roads, did not deter ungulates. The other two studies found mixed results with repellents temporarily deterring some ungulate species in one study and one of three deterrents deterring caribou in the other.

Assessment: unlikely to be beneficial (effectiveness 20%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2615>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Modify vegetation along roads to reduce collisions with mammals by enhancing visibility for drivers
- Remove roadkill regularly to reduce kill rate of predators/scavengers
- Retain/maintain road verges as small mammal habitat
- Use alternative de-icers on roads
- Use reflective collars or paint on mammals to reduce collisions with road vehicles
- Use wildlife decoy to reduce vehicle collisions with mammals.



15.4.2 Utility and service lines

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for utility and service lines?	
Likely to be beneficial	<ul style="list-style-type: none"> • Install crossings over/under pipelines

Likely to be beneficial

● Install crossings over/under pipelines

Three studies evaluated the effects on mammals of installing crossings over/under pipelines. Two studies were in the USA and one was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (3 STUDIES)

Use (3 studies): A study in USA found that buried pipeline sections were used more frequently than their availability as crossing points by caribou. A study in USA found that pipeline sections elevated specifically to permit mammal crossings underneath were not used by moose or caribou more than were other elevated sections. A controlled study in Canada found that a range of large mammal species used wildlife crossings over pipelines.

Assessment: likely to be beneficial (effectiveness 60%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2627>

15.4.3 Shipping lanes

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for shipping lanes?	
Likely to be beneficial	<ul style="list-style-type: none"> • Install overpasses over waterways • Provide mammals with escape routes from canals
No evidence found (no assessment)	<ul style="list-style-type: none"> • Install barrier fencing along waterways

Likely to be beneficial

● Install overpasses over waterways

Two studies evaluated the effects on mammals of installing overpasses over waterways. One study was in the USA and one was in Spain.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (2 STUDIES)

Use (2 studies): Two studies (one replicated, one a site comparison) in the USA and Spain, found that bridges and overpasses over waterways were used by desert mule deer, collared peccaries and coyotes and by a range of large and medium-sized mammals.

Assessment: likely to be beneficial (effectiveness 70%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2628>

● Provide mammals with escape routes from canals

Five studies evaluated the effects on mammals of providing mammals with escape routes from canals. Two studies were in Germany and one each was in the USA, the Netherlands and Argentina.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Survival (2 studies): One of two studies (one before-and-after), in Germany and the USA, found that ramps and ladders reduced mule deer drownings whilst the other study found that ramps and shallow-water inlets did not reduce mammal drownings.

BEHAVIOUR (3 STUDIES)

Use (3 studies): Three studies (one replicated) in Germany, the Netherlands and Argentina, found that ramps and other access or escape routes out of water were used by a range of medium-sized and large mammals species.

Assessment: likely to be beneficial (effectiveness 60%; certainty 45%; harms 0%).

<https://www.conservationevidence.com/actions/2638>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Install barrier fencing along waterways.

15.5 Threat: Biological resource use

15.5.1 Hunting and collecting terrestrial animals

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for hunting and collecting terrestrial animals?	
Likely to be beneficial	<ul style="list-style-type: none">• Prohibit or restrict hunting of a species• Provide/increase anti-poaching patrols• Set hunting quotas based on target species population trends
Unknown effectiveness	<ul style="list-style-type: none">• Ban exports of hunting trophies• Ban private ownership of hunted mammals• Incentivise species protection through licensed trophy hunting• Prohibit or restrict hunting of particular sex/ breeding status/age animals• Site management for target mammal species carried out by field sport practitioners• Use wildlife refuges to reduce hunting impacts
No evidence found (no assessment)	<ul style="list-style-type: none">• Commercially breed for the mammal production trade• Make introduction of non-native mammals for sporting purposes illegal• Promote mammal-related ecotourism• Promote sustainable alternative livelihoods• Use selective trapping methods in hunting activities

Likely to be beneficial

● Prohibit or restrict hunting of a species

Five studies evaluated the effects of prohibiting or restricting hunting of a mammal species. One study each was in Norway, the USA, South Africa, Poland and Zimbabwe.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (5 STUDIES)

Abundance (2 studies): Two studies (including one before-and-after study), in the USA and Poland, found that prohibiting hunting led to population increases of tule elk and wolves.

Survival (3 studies): A before-and-after study in Norway found that restricting or prohibiting hunting did not alter the number of brown bears killed. A study in Zimbabwe reported that banning the hunting, possession and trade of Temminck's ground pangolins did not eliminate hunting of the species. A before-and-after study in South Africa found that increasing legal protection of leopards, along with reducing human-leopard conflict by promoting improved animal husbandry, was associated with increased survival.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 50%; certainty 45%; harms 0%).

<https://www.conservationevidence.com/actions/2597>

● Provide/increase anti-poaching patrols

Seven studies evaluated the effects of providing or increasing anti-poaching patrols on mammals. Two studies were in Thailand and one each was in Brazil, Iran, Lao People's Democratic Republic, South Africa and Tajikistan.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (7 STUDIES)

Abundance (6 studies): Two studies, in Thailand and Iran, found more deer and small mammals and more urial sheep and Persian leopards close to ranger stations (from which anti-poaching patrols were carried out) than further from them. One of three before-and-after studies, in Brazil, Thailand and Lao People's Democratic Republic, found that ranger patrols increased mammal abundance. The other two studies found that patrols did not increase tiger abundance. A site comparison study in Tajikistan found more snow leopard, argali, and ibex where anti-poaching patrols were conducted.

Survival (1 study): A study in South Africa found that anti-poaching patrols did not deter African rhinoceros poaching.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 65%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2618>

● **Set hunting quotas based on target species population trends**

Three studies evaluated the effects of setting hunting quotas for mammals based on target species population trends. One study each was in Canada, Spain and Norway.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Abundance (2 studies): Two studies, in Spain and Norway, found that restricting hunting and basing quotas on population targets enabled population increases for Pyrenean chamois and Eurasian lynx.

Survival (1 study): A before-and-after study in Canada found that setting harvest quotas based on population trends, and lengthening the hunting season, did not decrease the number of cougars killed by hunters.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 64%; certainty 42%; harms 0%).

<https://www.conservationevidence.com/actions/2607>

Unknown effectiveness

● **Ban exports of hunting trophies**

One study evaluated the effects of banning exports of hunting trophies on wild mammals. This study was in Cameroon.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A before-and-after study in Cameroon found similar hippopotamus abundances before and after a ban on exporting hippopotamus hunting trophies.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 10%; certainty 27%; harms 0%).

<https://www.conservationevidence.com/actions/2625>

● **Ban private ownership of hunted mammals**

One study evaluated the effects of banning private ownership of hunted mammals. This study was in Sweden.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A before-and-after study in Sweden found that fewer brown bears were reported killed after the banning of private ownership of hunted bears.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 70%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2602>

● **Incentivise species protection through licensed trophy hunting**

One study evaluated the effects on mammals of incentivising species protection through licensed trophy hunting. This study was in Nepal.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A study in Nepal found that after trophy hunting started, bharal abundance increased, though the sex ratio of this species, and of Himalayan tahr, became skewed towards females.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 60%; certainty 20%; harms 20%).

<https://www.conservationevidence.com/actions/2610>

● **Prohibit or restrict hunting of particular sex/ breeding status/age animals**

Two studies evaluated the effects of prohibiting or restricting hunting of particular sex, breeding status or age animals. Both studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Reproduction (2 studies): Two replicated, before-and-after studies, in the USA, found that limiting hunting of male deer did not increase the numbers of young deer/adult female.

Population structure (1 study): A replicated, before-and-after study in the USA found that limiting hunting of older male elk resulted in an increased ratio of male:female elk.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 50%; certainty 35%; harms 0%).

<https://www.conservationevidence.com/actions/2609>

● Site management for target mammal species carried out by field sport practitioners

One study evaluated the effects of site management for a target mammal species being carried out by field sport practitioners. This study was in Ireland.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A replicated, site comparison study in the Republic of Ireland found that sites managed for the sport of coursing Irish hares held more of this species than did the wider countryside.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 65%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2605>

● Use wildlife refuges to reduce hunting impacts

Two studies evaluated the effects on mammal species of using wildlife refuges to reduce hunting impacts. One study was in Canada and one was in Mexico.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): One of two replicated site comparison studies in Canada and Mexico found more moose in areas with limited hunting than in more heavily hunted areas. The other study found mixed results with only one of five species being more numerous in a non-hunted refuge.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 50%; certainty 35%; harms 0%).

<https://www.conservationevidence.com/actions/2612>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Commercially breed for the mammal production trade
- Make introduction of non-native mammals for sporting purposes illegal
- Promote mammal-related ecotourism
- Promote sustainable alternative livelihoods
- Use selective trapping methods in hunting activities.

15.5.2 Logging and wood harvesting

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for logging and wood harvesting?	
Likely to be beneficial	<ul style="list-style-type: none"> • Thin trees within forest • Use patch retention harvesting instead of clearcutting • Use selective harvesting instead of clearcutting
Unknown effectiveness	<ul style="list-style-type: none"> • Allow forest to regenerate naturally following logging • Apply fertilizer to trees • Clear or open patches in forests • Fell trees in groups, leaving surrounding forest unharvested • Gather coarse woody debris into piles after felling • Leave coarse woody debris in forests • Leave standing deadwood/snags in forests • Plant trees following clearfelling • Provide supplementary feed to reduce tree damage • Remove competing vegetation to allow tree establishment in clearcut areas • Retain dead trees after uprooting • Retain understorey vegetation within plantations • Retain undisturbed patches during thinning operations • Retain wildlife corridors in logged areas • Use thinning of forest instead of clearcutting
No evidence found (no assessment)	<ul style="list-style-type: none"> • Control firewood collection in remnant native forest and woodland • Coppice trees • Harvest timber outside mammal reproduction period • Retain riparian buffer strips during timber harvest • Use tree tubes/small fences/cages to protect individual trees

Likely to be beneficial

● Thin trees within forest

Twelve studies evaluated the effects on mammals of thinning trees within forests. Six studies were in Canada and six were in the USA.

COMMUNITY RESPONSE (2 STUDIES)

Species richness (2 studies): A replicated, site comparison study the USA found that in thinned tree forest stands, there was similar mammal species richness compared to in unthinned stands. A replicated, controlled study in Canada found that thinning of regenerating lodgepole pine did not increase small mammal species richness 12–14 years later.

POPULATION RESPONSE (8 STUDIES)

Abundance (8 studies): Three of eight replicated, controlled and replicated, site comparison studies, in the USA and Canada, found that thinning trees within forests lead to higher numbers of small mammals. Two studies showed increases for some, but not all, small mammal species with a further study showing an increase for one of two squirrel species in response to at least some forest thinning treatments. The other two studies showed no increases in abundances of small mammals or northern flying squirrels between 12 and 14 years after thinning.

BEHAVIOUR (4 STUDIES)

Use (4 studies): Three of four controlled and comparison studies (three also replicated, one randomized) in Canada found that thinning trees within forests did not lead to greater use of areas by mule deer, moose or snowshoe hares. The other study found that a thinned area was used more by white-tailed deer than was unthinned forest.

Assessment: likely to be beneficial (effectiveness 40%; certainty 42%; harms 0%).

<https://www.conservationevidence.com/actions/2650>

● Use patch retention harvesting instead of clearcutting

Three studies evaluated the effects on mammals of using patch retention harvesting instead of clearcutting. Two studies were in Canada and one was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Abundance (3 studies): Two replicated, controlled, before-and-after studies and a replicated, site comparison study in Canada and Australia found that retaining patches of unharvested trees instead of clearcutting whole forest stands increased or maintained numbers of some but not all small mammals.

Higher abundances where tree patches were retained were found for southern red-backed voles, bush rat and for female agile antechinus. No benefit of retaining forest patches was found on abundances of deer mouse, meadow vole and male agile antechinus.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 50%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2639>

● **Use selective harvesting instead of clearcutting**

Eight studies evaluated the effects on mammals of using selective harvesting instead of clearcutting. Four studies were in Canada, three were in the USA and one was a review of studies in North America.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A replicated, site comparison study in Canada found that harvesting trees selectively did not result in higher small mammal species richness compared to clearcutting.

POPULATION RESPONSE (7 STUDIES)

Abundance (7 studies): One of six replicated, controlled or replicated, site comparison studies in the USA and Canada found more small mammals in selectively harvested forest stands than in fully harvested, regenerating stands. Three studies found that selective harvesting did not increase small mammal abundance relative to clearcutting. The other two studies found mixed results with one of four small mammal species being more numerous in selectively harvested stands or in selectively harvested stands only in some years. A systematic review in North American forests found that partially harvested forests had more red-backed voles but not deer mice than did clearcut forests.

BEHAVIOUR (1 STUDY)

Use (1 study): A site comparison study in the USA found that partially harvested forest was not used by snowshoe hares more than was largely clearcut forest.

Assessment: likely to be beneficial (effectiveness 40%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2637>

Unknown effectiveness

● **Allow forest to regenerate naturally following logging**

One study evaluated the effects on mammals of allowing forest to regenerate naturally following logging. This study was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A replicated, site comparison study in Canada found that, natural forest regeneration increased moose numbers relative to more intensive management in the short- to medium-term but not in the longer term.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 45%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2634>

● **Apply fertilizer to trees**

Three studies evaluated the effects on mammals of applying fertilizer to trees. All three studies were in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (3 STUDIES)

Use (3 studies): One of three replicated studies (including one controlled study and two site comparison studies), in Canada, found that thinned forest stands to which fertilizer was applied were used more by snowshoe hares in winter but not in summer over the short-term. The other studies found that forest stands to which fertilizer was applied were not more used by snowshoe hares in the longer term or by mule deer or moose.

Assessment: unknown effectiveness (effectiveness 30%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2649>

● **Clear or open patches in forests**

Four studies evaluated the effects on mammals of clearing or opening patches in forests. Two studies were in the USA, one was in Bolivia and one was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (4 STUDIES)

Abundance (4 studies): Two of four replicated studies (including three controlled studies and a site comparison study), in Bolivia, the USA and Canada, found that creating gaps or open patches within forests did not increase small mammal abundance relative to uncut forest. One study found that it did increase small mammal abundance and one found increased abundance for one of four small mammal species.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 32%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2641>

● **Fell trees in groups, leaving surrounding forest unharvested**

Three studies evaluated the effects on mammals of felling trees in groups, leaving surrounding forest unharvested. Two studies were in Canada and one was in the UK.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Abundance (2 studies): One of two replicated studies (including one controlled study and one site comparison study), in Canada, found that felling groups of trees within otherwise undisturbed stands increased the abundance of one of four small mammal species relative to clearcutting. The other study found that none of four small mammal species monitored showed abundance increases.

Survival (1 study): A study in the UK found that when trees were felled in large groups with surrounding forest unaffected, there was less damage to artificial hazel dormouse nests than when trees were felled in small groups or thinned throughout.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 40%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2648>

● **Gather coarse woody debris into piles after felling**

Two studies evaluated the effects on mammals of gathering coarse woody debris into piles after felling. Both studies were in Canada.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A randomized, replicated, controlled study in Canada found higher mammal species richness where coarse woody debris was gathered into piles.

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): One of two randomized, replicated, controlled studies in Canada found higher counts of San Bernardino long-tailed voles where coarse woody debris was gathered into piles. The other study found higher small mammal abundance at one of three plots where debris was gathered into piles.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 70%; certainty 31%; harms 0%).

<https://www.conservationevidence.com/actions/2653>

● **Leave coarse woody debris in forests**

Three studies evaluated the effects on mammals of leaving coarse woody debris in forests. One study was in Canada, one was in the USA and one was in Malaysia.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A replicated, site comparison study, in Malaysia found more small mammal species groups in felled forest areas with woody debris than without.

POPULATION RESPONSE (3 STUDIES)

Abundance (3 studies): One out of three replicated studies (two controlled, one site comparison, one before-and-after) in Canada, the USA and Malaysia found that retaining or adding coarse woody debris did not increase numbers or frequency of records of small mammals. The other study found that two of three shrew species were more numerous in areas with increased volumes of coarse woody debris than areas without coarse woody debris.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 50%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2647>

● **Leave standing deadwood/snags in forests**

One study evaluated the effects on mammals of leaving standing deadwood or snags in forests. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A replicated, controlled study in the USA found that increasing the quantity of standing deadwood in forests increased the abundance of one of three shrew species, compared to removing deadwood.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 55%; certainty 25%; harms 0%).

<https://www.conservationevidence.com/actions/2646>

● **Plant trees following clearfelling**

One study evaluated the effects on mammals of planting trees following clearfelling. This study was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated, site comparison study in Canada found that forest

stands subject to tree planting and herbicide treatment after logging were used more by American martens compared to naturally regenerating stands. *Assessment: unknown effectiveness (effectiveness 50%; certainty 20%; harms 0%).*

<https://www.conservationevidence.com/actions/2631>

● **Provide supplementary feed to reduce tree damage**

One study evaluated the effects of providing supplementary feed on the magnitude of tree damage caused by mammals. This study was in USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human-wildlife conflict (1 study): A replicated, randomized, paired sites, controlled, before-and-after study in USA found that supplementary feeding reduced tree damage by black bears.

Assessment: unknown effectiveness (effectiveness 70%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2629>

● **Remove competing vegetation to allow tree establishment in clearcut areas**

Three studies evaluated the effects on mammals of removing competing vegetation to allow tree establishment in clearcut areas. Two studies were in Canada and one was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (3 STUDIES)

Use (3 studies): One of three studies (including two controlled studies and one site comparison study), in the USA and Canada, found that where competing vegetation was removed to allow tree establishment in clearcut areas, American martens used the areas more. One study found mixed results for moose and one found no increase in site use by snowshoe hares.

Assessment: unknown effectiveness (effectiveness 40%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2644>

● **Retain dead trees after uprooting**

One study evaluated the effects on mammals of retaining dead trees after uprooting. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated, controlled study in the USA found that areas where trees were uprooted but left on site were used more by desert cottontails than were cleared areas.

Assessment: unknown effectiveness (effectiveness 60%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2642>

● Retain understorey vegetation within plantations

One study evaluated the effects on mammals of retaining understorey vegetation within plantations. This study was in Chile.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A replicated, controlled, before-and-after study in Chile found that areas with retained understorey vegetation had more species of medium-sized mammal, compared to areas cleared of understorey vegetation.

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated, controlled, before-and-after study in Chile found that areas with retained understorey vegetation had more visits from medium-sized mammals, compared to areas cleared of understorey vegetation.

Assessment: unknown effectiveness (effectiveness 62%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2645>

● Retain undisturbed patches during thinning operations

Two studies evaluated the effects on mammals of retaining undisturbed patches during thinning operations. Both studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (2 STUDIES)

Use (2 studies): Two randomized, replicated, controlled studies (one also before-and-after) in the USA found that snowshoe hares and tassel-eared squirrels used retained undisturbed forest patches more than thinned areas.

Assessment: unknown effectiveness (effectiveness 70%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2640>

● Retain wildlife corridors in logged areas

Two studies evaluated the effects on mammals of retaining wildlife corridors in logged areas. One study was in Australia and one was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (2 STUDIES)

Use (2 studies): A replicated study in Australia found that corridors of trees, retained after harvesting, supported seven species of arboreal marsupial. A replicated, controlled study in Canada found that lines of woody debris through clearcut areas that were connected to adjacent forest were not used more by red-backed voles than were isolated lines of woody debris.

Assessment: unknown effectiveness (effectiveness 50%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2651>

● Use thinning of forest instead of clearcutting

One study evaluated the effects on mammals of using thinning of forest instead of clearcutting. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated, controlled study in the USA found that thinned forest areas were used more by desert cottontails than were fully cleared or uncleared areas.

Assessment: unknown effectiveness (effectiveness 60%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2643>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Control firewood collection in remnant native forest and woodland
- Coppice trees
- Harvest timber outside mammal reproduction period
- Retain riparian buffer strips during timber harvest
- Use tree tubes/small fences/cages to protect individual trees.

15.6 Threat: Human intrusions and disturbance

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for human intrusions and disturbance?	
Beneficial	<ul style="list-style-type: none"> • Exclude or limit number of visitors to reserves or protected areas
Likely to be beneficial	<ul style="list-style-type: none"> • Use conditioned taste aversion to reduce human-wildlife conflict in non-residential sites • Use non-lethal methods to deter carnivores from attacking humans • Use prescribed burning • Use signs or access restrictions to reduce disturbance to mammals
Trade-off between benefit and harms	<ul style="list-style-type: none"> • Translocate mammals that have habituated to humans (e.g. bears)
Unknown effectiveness	<ul style="list-style-type: none"> • Habituate mammals to visitors • Treat mammals to reduce conflict caused by disease transmission to humans
No evidence found (no assessment)	<ul style="list-style-type: none"> • Provide paths to limit extent of disturbance to mammals • Set maximum number of people/vehicles approaching mammals • Set minimum distances for approaching mammals • Use voluntary agreements with locals to reduce disturbance

Beneficial

● Exclude or limit number of visitors to reserves or protected areas

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, one was in Ecuador and one was in Thailand.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Abundance (1 study): A site comparison study in Ecuador 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 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 and Thailand, found that restricting human access to protected areas resulted in increased use of these areas by grizzly bears and leopards.

Assessment: beneficial (effectiveness 80%; certainty 70%; harms 0%).

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

Likely to be beneficial

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

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.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

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

Assessment: likely to be beneficial (effectiveness 75%; certainty 50%; harms 0%).

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



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

Eight studies evaluated the effects of using non-lethal methods to deter carnivores from attacking humans. Three studies were in the USA, two were in Australia, one was in the USA and Canada, one was in Austria and one was in Bangladesh.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A study in Bangladesh 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 and Canada, found that pepper spray caused all or most American black bears and grizzly bears to flee or cease aggressive behaviour. One of these studies also showed that tear gas repelled half of American black bears. Two studies in the USA and Austria found that grizzly/brown bears were repelled by rubber bullets or by a range of deterrents including rubber bullets, chasing, shouting and throwing items. A study in the USA 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 found that ultrasonic sound deterrent units did not affect feeding location choices of dingoes. A study in Bangladesh found that domestic dogs accompanying people gave advance warning of tiger presence, enabling people to take precautionary actions. A study in Australia 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.

Assessment: likely to be beneficial (effectiveness 62%; certainty 60%; harms 0%).

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

● Use prescribed burning

Thirty-seven studies evaluated the effects on mammals of using prescribed burning. Twenty-five studies were in the USA, three each were in Canada and South Africa, two each were in Spain and Tanzania and one each was in France and Australia.

COMMUNITY RESPONSE (2 STUDIES)

Richness/diversity (2 studies): A replicated, randomized, controlled study

in the USA found similar small mammal species richness after prescribed burning compared to in unburned forest. A replicated, site comparison study in Australia found that prescribed burns early in the dry season resulted in higher small mammal species richness relative to wildfires later in the season.

POPULATION RESPONSE (16 STUDIES)

Abundance (11 studies): Five of 10 replicated studies (of which eight were controlled and two were site comparisons), in the USA, Spain and Australia, found that prescribed burning did not increase abundances of small mammals. Three studies found mixed effects, on cottontail rabbits and small mammals and two found that burning increased numbers of European rabbits and small mammals. A systematic review in the USA found that two mammal species showed positive responses (abundance or reproduction) to prescribed burning while three showed no response.

Reproductive success (1 study): A before-and-after, site comparison study in South Africa found that 92% of Cape mountain zebra foals were produced in the three years post-fire compared to 8% in the three years pre-fire.

Condition (1 study): A replicated, controlled study, in the USA, found that prescribed burning did not reduce bot fly infestation rates among rodents and cottontail rabbits.

Occupancy/range (3 studies): Two of three studies (including two site comparisons and one controlled study), in the USA and Canada, found that prescribed burning resulted in larger areas being occupied by black-tailed prairie dog colonies and smaller individual home ranges of Mexican fox squirrels. The third study found that prescribed burning did not increase occupancy rates of beaver lodges.

BEHAVIOUR (22 STUDIES)

Use (21 studies): Ten of 21 studies (including eight controlled studies and eight site comparisons with a further four being before-and-after studies), in the USA, Canada, South Africa, Tanzania and France, found that prescribed burning increased use of areas (measured either as time spent in areas or consumption of food resources) by bighorn sheep, mule deer, pronghorn antelope, elk, plains bison, Cape mountain zebra and mouflon. Six studies found mixed effects, with responses differing among different ages or sexes of white-tailed deer, bison and elk, differing among different large herbivore species or varying over time for elk, while swift foxes denned more but did not hunt more in burned areas. The other five studies showed that prescribed burning did not increase use or herbivory by elk, black-tailed deer, white-tailed deer or mixed species groups of mammalian herbivores.

Behaviour change (1 study): A site comparison study in Tanzania found that

vigilance of Thomson's gazelles did not differ between those on burned and unburned areas.

Assessment: likely to be beneficial (effectiveness 49%; certainty 50%; harms 5%).

<https://www.conservationevidence.com/actions/2388>

● Use signs or access restrictions to reduce disturbance to mammals

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

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

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

Assessment: likely to be beneficial (effectiveness 80%; certainty 40%; harms 0%).

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

Trade-off between benefit and harms

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

Two studies evaluated the effects of translocating mammals that have habituated to humans. One study was in the USA and one was in the USA and Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human-wildlife conflict (2 studies): A study in the USA found that almost half of the translocated 'nuisance' black bears returned to their capture locations. A review of studies in the USA and Canada 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.

Assessment: trade-off between benefit and harms (effectiveness 50%; certainty 49%; harms 20%).

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

Unknown effectiveness

● Habituate mammals to visitors

One study evaluated the effects of habituating mammals to visitors. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

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

Assessment: unknown effectiveness (effectiveness 50%; certainty 20%; harms 10%).

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

● Treat mammals to reduce conflict caused by disease transmission to humans

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

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 found that following a worming programme, proportions of red foxes infested with small fox tapeworm fell.

Assessment: unknown effectiveness (effectiveness 50%; certainty 30%; harms 0%).

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

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Provide paths to limit extent of disturbance to mammals
- Set maximum number of people/vehicles approaching mammals
- Set minimum distances for approaching mammals
- Use voluntary agreements with locals to reduce disturbance.

15.7 Threat: Natural system modifications

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for natural system modifications?	
Likely to be beneficial	<ul style="list-style-type: none"> • Burn at specific time of year • Provide artificial waterholes in dry season • Remove mid-storey vegetation in forest • Remove trees and shrubs to recreate open areas of land • Thin trees to reduce wildfire risk
Unknown effectiveness	<ul style="list-style-type: none"> • Provide supplementary food after fire
Unlikely to be beneficial	<ul style="list-style-type: none"> • Remove burnt trees and branches after wildfire • Remove understorey vegetation in forest
No evidence found (no assessment)	<ul style="list-style-type: none"> • Provide shelter structures after fire • Use fencing to protect water sources for use by wild mammals

Likely to be beneficial

● Burn at specific time of year

Two studies evaluated the effects on mammals of burning at a specific time of year. One study was in Australia, and one was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A replicated, randomized, controlled, before-and-after study in the USA found that carrying out prescribed burns in autumn did not increase small mammal abundances or biomass relative to burning in summer.

Survival (1 study): A randomized, replicated, controlled study in Australia found that in forest burned early in the dry season, northern brown bandicoot survival rate declined less than in forests burned late in the dry season.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 50%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2416>

● **Provide artificial waterholes in dry season**

Three studies evaluated the effects on mammals of providing artificial waterholes in the dry season. One study was in South Africa, one was in Tanzania and one was in Jordan.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A site comparison study in Tanzania found that artificial waterholes were used by a similar number of large mammal species as was a natural waterhole.

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (2 STUDIES)

Use (2 studies): A study in South Africa found that areas around artificial waterholes were used more by eight out of 13 mammalian herbivore species than was the wider landscape. A study in Jordan found that artificial waterholes were used by striped hyenas.

Assessment: likely to be beneficial (effectiveness 60%; certainty 40%; harms 10%).

<https://www.conservationevidence.com/actions/2484>

● **Remove mid-storey vegetation in forest**

One study evaluated the effects on mammals of removing mid-storey vegetation in forest. This study was in the USA.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A randomized, replicated, controlled study in the USA found that after removing mid-storey vegetation, mammal species richness increased.

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A randomized, replicated, controlled study in the

USA found that after removing mid-storey vegetation, mammal abundance increased.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 65%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2480>

● **Remove trees and shrubs to recreate open areas of land**

Two studies evaluated the effects on mammals of removing trees and shrubs to recreate open areas of land. Both studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A controlled study in the USA found that where Ashe juniper trees were removed, there were higher abundances of three rodent species.

BEHAVIOUR (1 STUDY)

Use (1 study): A before-and-after, site comparison study in the USA found that removing trees increased use of areas by Rocky Mountain bighorn sheep.

Assessment: likely to be beneficial (effectiveness 70%; certainty 45%; harms 0%).

<https://www.conservationevidence.com/actions/2483>

● **Thin trees to reduce wildfire risk**

Three studies evaluated the effects on mammals of thinning trees to reduce wildfire risk. All three studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): A replicated, controlled, before-and-after study in the USA found that reducing tree density increased abundances of two of four small mammal species. A systematic review in the USA found that, in thinned forests, two mammal species were recorded in higher densities compared to in unmanaged forests, while three species showed no effect.

BEHAVIOUR (1 STUDY)

(1 study): A replicated, controlled study in the USA found that thinning followed by prescribed burning did not increase use of forest areas by North American elk in most season, stand age and sex comparisons.

Assessment: likely to be beneficial (effectiveness 50%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2477>

Unknown effectiveness

● Provide supplementary food after fire

One study evaluated the effects on mammals of providing supplementary food after fire. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A replicated, randomized, controlled study in the USA found that supplementary feeding did not increase survival of hispid cotton rats following prescribed fire.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 0%; certainty 21%; harms 0%).

<https://www.conservationevidence.com/actions/2494>

Unlikely to be beneficial

● Remove burnt trees and branches after wildfire

One study evaluated the effects on mammals of removing burnt trees and branches after wildfire. This study was in Spain.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A replicated, randomized, controlled study in Spain found that removing burned trees and branches after wildfire did not increase European wild rabbit numbers compared to removing burned trees but leaving branches in place.

BEHAVIOUR (0 STUDIES)

Assessment: unlikely to be beneficial (effectiveness 0%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2478>

● Remove understorey vegetation in forest

Three studies evaluated the effects on mammals of removing understorey vegetation in forest. All three studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Abundance (3 studies): Three replicated, randomized, controlled studies (two also before-and-after), in the USA, found that compared to prescribed burning, mechanically removing understorey vegetation growth in forests did

not increase abundances of white-footed mice, shrews or four rodent species.

BEHAVIOUR (0 STUDIES)

Assessment: unlikely to be beneficial (effectiveness 10%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2482>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Provide shelter structures after fire
- Use fencing to protect water sources for use by wild mammals.

15.8 Threat: Invasive alien and other problematic species

15.8.1 Invasive non-native/alien species/diseases

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for invasive non-native/alien species/diseases?	
Beneficial	<ul style="list-style-type: none"> • Remove/control non-native mammals
Likely to be beneficial	<ul style="list-style-type: none"> • Remove/control non-native mammals within a fenced area • Use conditioned taste aversion to prevent non-target species from entering traps • Use drugs to treat parasites • Use reward removal to prevent non-target species from entering traps
Unknown effectiveness	<ul style="list-style-type: none"> • Modify traps used in the control/eradication of non-native species to avoid injury of non-target mammal • Remove/control non-native invertebrates • Remove/control non-native plants
No evidence found (no assessment)	<ul style="list-style-type: none"> • Control non-native prey species to reduce populations and impacts of non-native predators • Control non-native/problematic plants to restore habitat • Provide artificial refuges for prey to evade/escape non-native predators • Reintroduce top predators to suppress and reduce the impacts of smaller non-native predator and prey species • Remove/control non-native amphibians (e.g. cane toads) • Remove/control non-native species that could interbreed with native species



Beneficial

● Remove/control non-native mammals

Twenty-five studies evaluated the effects on non-controlled mammals of removing or controlling non-native mammals. Twenty-one studies were in Australia, and one was in each of France, the UK, Equador and the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (24 STUDIES)

Abundance (21 studies): Ten of 18 controlled, before-and-after or site comparison studies, in Australia, found that after controlling red foxes, abundances, densities or trapping frequencies increased for rock-wallaby spp., eastern grey kangaroo, woylie,, brush-tail possum, tammar wallaby, chuditch and quenda. Seven studies found mixed results with increases in some species but not others, increases followed by declines or increases only where cats as well as foxes were controlled. The other study found no increase in bush rat numbers with fox control. One of three replicated, before-and-after studies (including two controlled studies), in Australia, France and Ecuador, found that control of invasive rodents increased numbers of lesser white-toothed shrews and greater white-toothed shrews. One study found that Santiago rice rat abundance declined less with rodent control and one found mixed results, with increased numbers of short-tailed mice at one out of four study sites.

Survival (1 study): A replicated, controlled study in Australia found that controlling red foxes increased survival of juvenile eastern grey kangaroos.

Occupancy/range (3 studies): Three studies (two before-and-after, one controlled), in the UK and Australia, found that after controlling non-native American mink, red foxes and European rabbits, there were increases in ranges or proportions of sites occupied by water vole, common brushtail possum, long-nosed potoroo and southern brown bandicoot and four native small mammal species.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A before-and-after study in the USA found that following removal of feral cats, vertebrate prey increased as a proportion of the diet of island foxes.

Assessment: beneficial (effectiveness 67%; certainty 70%; harms 10%).

<https://www.conservationevidence.com/actions/2504>

Likely to be beneficial

● **Remove/control non-native mammals within a fenced area**

One study evaluated the effects on native mammals of removing or controlling non-native mammals within a fenced area. This study was in Australia.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A site comparison study in Australia found that in a fenced area where invasive cats, red foxes and European rabbits were removed, native mammal species richness was higher than outside the fenced area.

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A site comparison study in Australia found that in a fenced area where invasive cats, red foxes and European rabbits were removed, native mammals overall and two out of four small mammal species were more abundant than outside the fenced area.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 65%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2528>

● **Use conditioned taste aversion to prevent non-target species from entering traps**

One study evaluated the effects on mammals of using conditioned taste aversion to prevent non-target species from entering traps. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A replicated, controlled study in the USA found that using bait laced with lithium chloride reduced the rate of entry of San Clemente Island foxes into traps set for feral cats.

Assessment: likely to be beneficial (effectiveness 60%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2536>

● **Use drugs to treat parasites**

Seven studies evaluated the effects on mammals of using drugs to treat parasites. Three studies were in the USA, two were in Spain, one was in Germany and one was in Croatia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (7 STUDIES)

Survival (1 study): A randomized, replicated, controlled study the USA found that medical treatment of Rocky Mountain bighorn sheep against lungworm did not increase lamb survival.

Condition (6 studies): Three of four before-and-after studies (one controlled), in Germany, the USA and Croatia, found that after administering drugs to mammals, parasite burdens were reduced in roe deer and in wild boar piglets and numbers of white-tailed deer infected were reduced. A third study found that levels of lungworm larvae in bighorn sheep faeces were reduced one month after drug treatment but not after three to seven months. One of these studies also found that the drug treatment resulted in increased body weight in roe deer fawns. A replicated, controlled, before-and-after study in Spain found that higher doses of ivermectin treated sarcoptic mange in Spanish ibex faster than lower doses, and treatment was more effective in animals with less severe infections. A replicated, before-and-after study in Spain found that after injecting Spanish ibex with ivermectin to treat sarcoptic mange a mange-free herd was established.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 55%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2587>

● Use reward removal to prevent non-target species from entering traps

One study evaluated the effects on mammals of using reward removal to prevent non-target species from entering traps. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A replicated, controlled study in the USA found that when reward removal was practiced, the rate of San Clemente Island fox entry into traps set for feral cats was reduced.

Assessment: likely to be beneficial (effectiveness 60%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2537>

Unknown effectiveness

● **Modify traps used in the control/eradication of non-native species to avoid injury of non-target mammal**

One study evaluated the effects of modifying traps used in the control or eradication of non-native species to avoid injury of non-target mammals. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Condition (1 study): A before-and-after study in the USA found that modifying traps used for catching non-native mammals reduced moderate but not severe injuries among incidentally captured San Nicolas Island foxes.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 40%; certainty 22%; harms 0%).

<https://www.conservationevidence.com/actions/2535>

● **Remove/control non-native invertebrates**

One study evaluated the effects on mammals of removing or controlling non-native invertebrates. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A replicated, controlled, before-and-after study the USA found that after the control of red imported fire ants, capture rates of northern pygmy mice increased.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 67%; certainty 25%; harms 0%).

<https://www.conservationevidence.com/actions/2501>

● **Remove/control non-native plants**

Two studies evaluated the effects on mammals of removing or controlling non-native invasive plants. Both studies were in the USA.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A replicated study in the USA found that control of introduced saltcedar did not change small mammal species richness.

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A site comparison study in the USA found that partial removal of velvet mesquite did not increase abundances of six mammal species.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 8%; certainty 25%; harms 0%).

<https://www.conservationevidence.com/actions/2529>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Control non-native prey species to reduce populations and impacts of non-native predators
- Control non-native/problematic plants to restore habitat
- Provide artificial refuges for prey to evade/escape non-native predators
- Reintroduce top predators to suppress and reduce the impacts of smaller non-native predator and prey species
- Remove/control non-native amphibians (e.g. cane toads)
- Remove/control non-native species that could interbreed with native species.

15.8.2 Problematic native species/diseases

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for problematic native species/diseases?	
Beneficial	<ul style="list-style-type: none"> • Use vaccination programme
Likely to be beneficial	<ul style="list-style-type: none"> • Cull disease-infected animals
Trade-off between benefit and harms	<ul style="list-style-type: none"> • Remove or control predators
Unknown effectiveness	<ul style="list-style-type: none"> • Control ticks/fleas/lice in wild mammal populations • Establish populations isolated from disease • Provide diversionary feeding for predators • Remove or control competitors • Sterilize predators • Train mammals to avoid problematic species • Treat disease in wild mammals

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for problematic native species/diseases?	
No evidence found (no assessment)	<ul style="list-style-type: none">• Eliminate highly virulent diseases early in an epidemic by culling all individuals (healthy and infected) in a defined area• Sterilize non-native domestic or feral species (e.g. cats and dogs)

Beneficial

● Use vaccination programme

Seven studies evaluated the effects on mammals of using vaccination programmes. Three studies were in the UK and one study was in each of Belgium, Spain, Poland and Ethiopia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (7 STUDIES)

Abundance (1 study): A before-and-after study in Poland found that following an anti-rabies vaccination programme, red fox numbers increased.

Condition (6 studies): Five studies (including three replicated, three controlled and two before-and-after studies) in Belgium, Spain and the UK found that following vaccination, rabies was less frequent in red foxes, numbers of Eurasian badgers infected with tuberculosis was reduced and European rabbits developed immunity to myxomatosis and rabbit haemorrhagic disease. One of the studies also found that vaccination reduced the speed and extent of infection in infected Eurasian badgers. A study in Ethiopia found that following vaccination of Ethiopian wolves, a rabies outbreak halted.

BEHAVIOUR (0 STUDIES)

Assessment: beneficial (effectiveness 80%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2582>

Likely to be beneficial

● Cull disease-infected animals

One study evaluated the effects on mammals of culling disease-infected animals. This study was in Tasmania.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Condition (1 study): A before-and-after, site comparison study in Tasmania found that culling disease-infected Tasmanian devils resulted in fewer animals with large tumours associated with late stages of the disease.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 60%; certainty 40%; harms 15%).

<https://www.conservationevidence.com/actions/2586>

Trade-off between benefit and harms

● Remove or control predators

Ten studies evaluated the effects on non-controlled mammals of removing or controlling predators. Seven studies were in North America, one was in Finland, one in Portugal and one in Mexico.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (10 STUDIES)

Abundance (6 studies): Three of six studies (including three controlled, one before-and-after and one replicated, paired sites study), in Finland Portugal, Mexico and the USA, found that removing predators increased abundances of pronghorns, moose and European rabbits and Iberian hares. One of these studies also found that mule deer abundance did not increase. The other three studies found that removing predators did not increase mountain hare, caribou or desert bighorn sheep abundance.

Reproductive success (2 studies): Two replicated, before-and-after studies (one also controlled), in the USA, found that predator removal was associated with increased breeding productivity of white-tailed deer and less of a productivity decline in pronghorns. However, one of these studies also found that there was no change in breeding productivity of mule deer.

Survival (5 studies): Two of five before-and-after studies (including two controlled studies and one replicated study), in the USA, Canada and the USA and Canada combined, found that controlling predators did not increase survival of caribou calves, or of calf or adult female caribou. Two studies found that moose calf survival and woodland caribou calf survival increased with predator control. The other study found mixed results with increases in white-tailed deer calf survival in some but not all years with predator control.

BEHAVIOUR (0 STUDIES)

Assessment: trade-off between benefit and harms (effectiveness 50%; certainty 50%; harms 46%).

<https://www.conservationevidence.com/actions/2613>

Unknown effectiveness

● Control ticks/fleas/lice in wild mammal populations

Two studies evaluated the effects of controlling ticks, fleas or lice in wild mammal populations. Both studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Condition (2 studies): A replicated, paired sites, controlled study in the USA found that a grain-bait insecticide product did not consistently reduce flea burdens on Utah prairie dogs. A controlled study the USA found that treating wolves with ivermectin cleared them of infestations of biting dog lice.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 50%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2589>

● Establish populations isolated from disease

One study evaluated the effects on mammals of establishing populations isolated from disease. The study was in sub-Saharan Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Condition (1 study): A site comparison study throughout sub-Saharan Africa found that fencing reduced prevalence of canine distemper but not of rabies, coronavirus or canine parvovirus in African wild dogs.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 25%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2588>

● Provide diversionary feeding for predators

One study evaluated the effects on potential prey mammals of providing diversionary feeding for predators. This study was in Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A controlled, before-and-after study in Canada found that diversionary feeding of predators appeared to increase woodland caribou calf survival.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 67%; certainty 20%; harms 0%).

<https://www.conservationevidence.com/actions/2578>

● **Remove or control competitors**

Two studies evaluated the effects on non-controlled mammals of removing or controlling competitors. One study was across Norway and Sweden and one was in Norway.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Reproductive success (1 study): A replicated, controlled study in Norway and Sweden found that red fox control, along with supplementary feeding, was associated with an increase in arctic fox litters.

BEHAVIOUR (1 STUDY)

Use (1 study): A controlled study in Norway found that where red foxes had been controlled arctic foxes were more likely to colonize.

Assessment: unknown effectiveness (effectiveness 70%; certainty 33%; harms 12%).

<https://www.conservationevidence.com/actions/2575>

● **Sterilize predators**

One study evaluated the effects on potential prey mammals of sterilizing predators. This study was in the USA and Canada.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A before-and-after study in the USA and Canada found that sterilising some wolves (combined with trapping and removing others) did not increase caribou survival.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 0%; certainty 15%; harms 0%).

<https://www.conservationevidence.com/actions/2573>

● **Train mammals to avoid problematic species**

Two studies evaluated the effects of training mammals to avoid problematic species. Both studies were in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A controlled study in Australia found that training greater bilbies to avoid introduced predators did not increase their post-release survival.

BEHAVIOUR (2 STUDIES)

Behaviour change (2 studies): One of two controlled studies in Australia found that greater bilbies trained to avoid introduced predators showed

more predator avoidance behaviour, the second study found no difference in behaviour between trained and untrained bilbies.

Assessment: unknown effectiveness (effectiveness 40%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2580>

● **Treat disease in wild mammals**

Three studies evaluated the effects on mammals of treating disease in the wild. Two studies were in the USA and one was in Germany.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Condition (2 studies): A replicated study in Germany found that medical treatment of mouflons against foot rot disease healed most infected animals. A before-and-after study in the USA found that management which included vaccination of Yellowstone bison did not reduce prevalence of brucellosis.

BEHAVIOUR (1 STUDY)

Uptake (1 study): A study in the USA found that a molasses-based bait was readily consumed by white-tailed deer, including when it contained a dose of a disease vaccination.

Assessment: unknown effectiveness (effectiveness 50%; certainty 32%; harms 0%).

<https://www.conservationevidence.com/actions/2581>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Eliminate highly virulent diseases early in an epidemic by culling all individuals (healthy and infected) in a defined area
- Sterilize non-native domestic or feral species (e.g. cats and dogs).

15.8.3 Other

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for other sources of non-native, invasive or other problematic species?	
Likely to be beneficial	<ul style="list-style-type: none">• Use fencing to exclude grazers or other problematic species• Use fencing to exclude predators or other problematic species



Likely to be beneficial

● Use fencing to exclude grazers or other problematic species

Three studies evaluated the effects on mammals of using fencing to exclude grazers or other problematic species. One study was in each of the USA, Australia and Spain.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A controlled, before-and-after study in Australia found that after fencing to exclude introduced herbivores, native mammal species richness increased.

POPULATION RESPONSE (3 STUDIES)

Abundance (3 studies): Two controlled studies (including one replicated, paired sites study) in Spain and Australia found that using fences to exclude large or introduced herbivores increased the abundance of Algerian mice and native mammals. A replicated, paired sites study in the USA found that in areas fenced to exclude livestock grazing and off-road vehicles, abundance of black-tailed hares was lower compared to in unfenced areas.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 50%; certainty 46%; harms 10%).

<https://www.conservationevidence.com/actions/2495>

● Use fencing to exclude predators or other problematic species

Ten studies evaluated the effects on mammals of using fencing to exclude predators or other problematic species. Four studies were in Australia, four were in the USA and two were in Spain.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A site comparison study in Australia found that fencing which excluded feral cats, foxes and rabbits increased small mammal species richness.

POPULATION RESPONSE (10 STUDIES)

Abundance (4 studies): Two of three studies (including two replicated, controlled studies), in Spain, Australia and the USA, found that abundances of European rabbits and small mammals were higher within areas fenced to exclude predators or other problematic species, compared to in unfenced areas. The third study found that hispid cotton rat abundance was not higher with predator fencing. A replicated, controlled study in Spain found that

translocated European rabbit abundance was higher in fenced areas that excluded both terrestrial carnivores and raptors than in areas only accessible to raptors.

Reproductive success (1 study): A replicated, controlled study in USA found that predator exclosures increased the number of white-tailed deer fawns relative to the number of adult females.

Survival (7 studies): Four of six studies (including four replicated, controlled studies) in Spain, Australia and the USA, found that fencing to exclude predators did not increase survival of translocated European rabbits, hispid cotton rats, southern flying squirrels or western barred bandicoots. The other two studies found that persistence of populations of eastern barred bandicoots and long-haired rats was greater inside than outside fences. A controlled, before-and-after study in the USA found that electric fencing reduced coyote incursions into sites frequented by black-footed ferrets.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 50%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2497>

15.9 Threat: Pollution

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for pollution?	
Likely to be beneficial	<ul style="list-style-type: none"> • Leave headlands in fields unsprayed
Unknown effectiveness	<ul style="list-style-type: none"> • Reduce pesticide or fertilizer use • Translocate mammals away from site contaminated by oil spill
No evidence found (no assessment)	<ul style="list-style-type: none"> • Establish riparian buffers

Likely to be beneficial

● Leave headlands in fields unsprayed

Two studies evaluated the effects on mammals of leaving headlands in fields unsprayed. One study was in the UK and one was in the Netherlands.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (2 STUDIES)

Use (2 studies): Two replicated studies (one also controlled) in the UK and the Netherlands, found that crop edge headlands that were not sprayed with pesticides were used more by mice than were sprayed crop edges.

Assessment: likely to be beneficial (effectiveness 60%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2540>

Unknown effectiveness

● Reduce pesticide or fertilizer use

Three studies evaluated the effects on mammals of reducing pesticide,

herbicide or fertilizer use. Two studies were in the UK, one was in Italy and one was in Argentina.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A replicated, site comparison study in Argentina found that farming without pesticides or fertilizers did not increase small mammal species richness in field margins.

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): One of two site comparison studies, in the UK and Italy, found that reducing pesticide or fertilizer use, by farming organically, increased wood mouse abundance. The other study found that it did not increase European hare abundance.

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated, site comparison study in Argentina found that farming without pesticides or fertilizers did not increase small mammal use of field margins.

Assessment: unknown effectiveness (effectiveness 38%; certainty 23%; harms 0%).

<https://www.conservationevidence.com/actions/2539>

● **Translocate mammals away from site contaminated by oil spill**

One study evaluated the effects of translocating mammals away from a site contaminated by oil spill. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A study in the USA found that after being translocated in a trial of responses to a hypothetical pollution incident, most sea-otters survived for the duration of monitoring.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A study in the USA found that after being translocated in a trial of responses to a hypothetical pollution incident, most sea-otters did not return to their capture location.

Assessment: unknown effectiveness (effectiveness 65%; certainty 20%; harms 10%).

<https://www.conservationevidence.com/actions/2542>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Establish riparian buffers.

15.10 Threat: Climate change and severe weather

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for climate change and severe weather?	
Unknown effectiveness	<ul style="list-style-type: none"> • Apply water to vegetation to increase food availability during drought • Translocate animals from source populations subject to similar climatic conditions
No evidence found (no assessment)	<ul style="list-style-type: none"> • Protect habitat along elevational gradients • Provide dams/water holes during drought • Remove flood water • Retain/provide migration corridors

Unknown effectiveness

● **Apply water to vegetation to increase food availability during drought**

One study evaluated the effects on mammals of applying water to vegetation to increase food availability during drought. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Use (1 study): A controlled, before-and-after study in the USA found that watering scrub during drought increased its use by adult Sonoran pronghorns for feeding.

Assessment: unknown effectiveness (effectiveness 70%; certainty 34%; harms 0%).

<https://www.conservationevidence.com/actions/2555>

● **Translocate animals from source populations subject to similar climatic conditions**

One study evaluated the effects of translocating mammals from source populations subject to similar climatic conditions. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Reproductive success (1 study): A study in the USA found that bighorn sheep translocated from populations subject to a similar climate to the recipient site reared more offspring than did those translocated from milder climatic areas.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 55%; certainty 25%; harms 0%).

<https://www.conservationevidence.com/actions/2553>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Protect habitat along elevational gradients
- Provide dams/water holes during drought
- Remove flood water
- Retain/provide migration corridors.

15.11 Habitat protection

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for habitat protection?	
Beneficial	<ul style="list-style-type: none">• Legally protect habitat for mammals
Unknown effectiveness	<ul style="list-style-type: none">• Build fences around protected areas• Increase resources for managing protected areas• Increase size of protected area
No evidence found (no assessment)	<ul style="list-style-type: none">• Encourage habitat protection of privately-owned land• Retain buffer zones around core habitat

Beneficial

● Legally protect habitat for mammals

Seven studies evaluated the effects of legally protecting habitat for mammals. One study each was in Zambia, the USA, Tanzania, Brazil, Nepal and India and one was a systematic review of sites with a wide geographic spread.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (7 STUDIES)

Abundance (7 studies): A systematic review of protected areas across the globe found that 24 of 31 studies reported an increase in mammal populations in protected areas relative to unprotected areas. Three studies (including two site comparison studies), in Zambia, the USA and Nepal, found that populations of red lechwe, black bears and one-horned rhinoceros grew following site protection or were higher than in adjacent non-protected sites. One of three site comparison studies, in Tanzania, Brazil and India, found

that populations of more mammal species increased inside protected areas than in adjacent unprotected areas. One study found that populations of only three of 11 species were higher on protected than on unprotected land whilst the third study found that 13 of 16 species were less abundant in a protected area than in a nearby unprotected area.

BEHAVIOUR (0 STUDIES)

Assessment: beneficial (effectiveness 70%; certainty 65%; harms 0%).

<https://www.conservationevidence.com/actions/2559>

Unknown effectiveness

● Build fences around protected areas

Two studies evaluated the effects on mammals of building fences around protected areas. One study was in Kenya and one was in Mozambique.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A before-and-after study in Kenya found that after a fence was built around a protected area, mammal species richness initially increased in both study sites, but subsequently declined at one of the sites.

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): A paired sites study in Mozambique found that inside a fenced sanctuary there were more mammal scats than outside the sanctuary. A before-and-after study in Kenya found that after a fence was built around a protected area, mammal abundance initially increased in both study sites, but it subsequently declined at one of the sites.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 50%; certainty 23%; harms 20%).

<https://www.conservationevidence.com/actions/2561>

● Increase resources for managing protected areas

One study evaluated the effects on mammals of increasing resources for managing protected areas. This study was in Tanzania.

COMMUNITY RESPONSE (1 STUDY)

Species richness (1 study): A site comparison study in Tanzania found that mammal species richness was higher in a well-resourced national park, than in a less well-resourced forest reserve.

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A site comparison study Tanzania found that there were greater occupancy rates or relative abundances of most mammal species in a well-resourced national park than in a less well-resourced forest reserve.
BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 80%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2564>

● Increase size of protected area

One study evaluated the effects on mammals of increasing the size of a protected area. This study was in South Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A before-and-after study in South Africa found that expanding a fenced reserve resulted in the home range of a reintroduced group of lions becoming larger but the core range becoming smaller.

Assessment: unknown effectiveness (effectiveness 55%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2563>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Encourage habitat protection of privately-owned land
- Retain buffer zones around core habitat.

15.12 Habitat restoration and creation

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for habitat restoration and creation?	
Beneficial	<ul style="list-style-type: none"> • Provide artificial dens or nest boxes on trees
Likely to be beneficial	<ul style="list-style-type: none"> • Create or maintain corridors between habitat patches • Manage vegetation using livestock grazing • Provide artificial refuges/breeding sites • Remove vegetation by hand/machine • Restore or create forest • Restore or create grassland • Restore or create savannas • Restore or create shrubland
Unknown effectiveness	<ul style="list-style-type: none"> • Apply fertilizer to vegetation to increase food availability • Manage vegetation using grazing by wild herbivores • Manage wetland water levels for mammal species • Provide more small artificial breeding sites rather than fewer large sites • Restore or create wetlands
Unlikely to be beneficial	<ul style="list-style-type: none"> • Remove vegetation using herbicides
No evidence found (no assessment)	<ul style="list-style-type: none"> • Remove topsoil that has had fertilizer added to mimic low nutrient soil • Replant vegetation



Beneficial

● Provide artificial dens or nest boxes on trees

Thirty studies evaluated the effects on mammals of providing artificial dens or nest boxes on trees. Fourteen studies were in Australia, nine were in the USA, three were in the UK, one was in each of Canada, Lithuania, South Africa and Japan.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (6 STUDIES)

Abundance (5 studies): Three of five controlled studies (three also replicated) in the USA, the UK, Canada and Lithuania, found that provision of artificial dens or nest boxes increased abundances of gray squirrels and common dormice. The other two studies found that northern flying squirrel and Douglas squirrel abundances did not increase.

Condition (1 study): A replicated, randomized, paired sites, controlled, before-and-after study in Canada found that nest boxes provision did not increase body masses of northern flying squirrel or Douglas squirrel.

BEHAVIOUR (27 STUDIES)

Use (27 studies): Twenty-seven studies, in Australia, the USA, the UK, Canada, South Africa and Japan found that artificial dens or nest boxes were used by a range of mammal species for roosting and breeding.

Assessment: beneficial (effectiveness 65%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2584>

Likely to be beneficial

● Create or maintain corridors between habitat patches

Four studies evaluated the effects on mammals of creating or maintaining corridors between habitat patches. One study was in each of Canada, the USA, Norway and the Czech Republic.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (4 STUDIES)

Use (4 studies): Four studies (three replicated) in Canada, the USA, Norway and the Czech Republic found that corridors between habitat patches were used by small mammals. Additionally, North American deermice moved further through corridors with increased corridor width and connectivity

and root voles moved further in corridors of intermediate width.

Assessment: likely to be beneficial (effectiveness 70%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2576>

● **Manage vegetation using livestock grazing**

Six studies evaluated the effects on mammals of managing vegetation using livestock grazing. Four studies were in the USA, one was in Norway and one was in Mexico.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A replicated, controlled, before-and-after study in the USA found that introduction of livestock grazing increased the abundance of Stephens' kangaroo rat after two years.

BEHAVIOUR (5 STUDIES)

Use (4 studies): One of four studies (three replicated controlled studies and a before-and-after study), in the USA and Norway, found that sheep-grazed pasture was used by feeding reindeer more than was ungrazed pasture. One found mixed effects on Rocky Mountain elk use of grazed plots and another found no response of Rocky Mountain elk to spring cattle grazing. The fourth study found cattle grazing to increase the proportion of rough fescue biomass utilized by elk in the first, but not second winter after grazing.

Behaviour change (1 study): A replicated, paired sites study in Mexico found that in pastures grazed by cattle, Tehuantepec jackrabbits spent more time feeding than they did in pastures not grazed by cattle.

Assessment: likely to be beneficial (effectiveness 50%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2545>

● **Provide artificial refuges/breeding sites**

Eight studies evaluated the effects on mammals of providing artificial refuges/breeding sites. Two studies were in each of the USA, Spain and Portugal and one was in each of Argentina and Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (4 STUDIES)

Abundance (3 studies): Two studies (one controlled), in Spain and Portugal, found that artificial warrens increased European rabbit abundance. A replicated, randomized, controlled, before-and-after study in Argentina found that artificial refuges did not increase abundances of small vesper mice or Azara's grass mice.

Survival (1 study): A study in USA found that artificial escape dens increased swift fox survival rates.

BEHAVIOUR (4 STUDIES)

Use (4 studies): Four studies (two replicated), in Australia, Spain, Portugal and the USA, found that artificial refuges, warrens or nest structures were used by fat-tailed dunnarts, European rabbits, and Key Largo woodrats and Key Largo cotton mice.

Assessment: likely to be beneficial (effectiveness 65%; certainty 55%; harms 0%).

<https://www.conservationevidence.com/actions/2583>

● Remove vegetation by hand/machine

Twenty studies evaluated the effects on mammals of removing vegetation by hand or machine. Eleven studies were in the USA, and one each was in Canada, South Africa, Israel, Norway, Portugal, France, Spain, the Netherlands and Thailand.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A site comparison study in the USA found that mechanically clearing trees within woodland reduced small mammal diversity.

POPULATION RESPONSE (12 STUDIES)

Abundance (11 studies): Eight of 11 site comparison or controlled studies (nine of which were replicated), in the USA, Israel, Portugal, Spain and the Netherlands, found that clearing woody vegetation or herbaceous and grassland vegetation benefitted target mammals. Population or density increases were recorded for small mammals, European rabbits and Stephens' kangaroo rat while black-tailed prairie dog and California ground squirrel colonies were larger or denser and Utah prairie dog colonies established better than in uncleared areas. Two studies found mixed results of clearing woody vegetation, with hazel dormouse abundance declining, then increasing and small mammal abundance increasing, then declining in both cleared and uncleared plots alike. One study found no effect of scrub clearance from sand dunes on habitat specialist small mammals.

Survival (1 study): A replicated, site comparison study in the USA found that mechanical disturbance of woody vegetation within forest (combined with reseeded, follow-up herbicide application and further seeding) increased overwinter survival of mule deer fawns.

BEHAVIOUR (8 STUDIES)

Use (8 studies): Four of seven studies (of which six were site comparisons or controlled), in the USA, Canada, Norway, France and Thailand, found that areas cleared of woody vegetation or herbaceous and grassland vegetation

were utilized more by mule deer, reindeer, mouflon and gaur. One study found that clearing woody vegetation promoted increased use by white-tailed deer in some but not all plots, one found that it did not increase use by mule deer and one found that carrying out a second clearance on previously cleared plots did not increase use by white-tailed deer. A before-and-after study in South Africa found that clearing woody vegetation from shrubland increased wildebeest and zebra abundance following subsequent burning but not when carried out without burning whilst other mammals did not show consistent responses.

Assessment: likely to be beneficial (effectiveness 65%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2550>

● **Restore or create forest**

Five studies evaluated the effects on mammals of restoring or creating forest. Two studies were in the USA and one each were in Colombia, Italy and Australia.

COMMUNITY RESPONSE (2 STUDIES)

Richness/diversity (2 studies): Two site comparison studies (one replicated) in the USA and Colombia found that mammal species richness in restored forest was similar to that in established forest.

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): One of two replicated studies (one a site comparison) in Australia and Italy found that replanted or regrowing forest supported a higher abundance of hazel dormice than did coppiced forest. The other study found only low numbers of common brushtail possums or common ringtail possums by 7–30 years after planting.

BEHAVIOUR (1 STUDY)

Usage (1 study): A replicated, site comparison study in the USA found that restored riparian forest areas were visited more by carnivores than were remnant forests when restored areas were newly established, but not subsequently, whilst restored areas were not visited more frequently by black-tailed deer.

Assessment: likely to be beneficial (effectiveness 55%; certainty 42%; harms 0%).

<https://www.conservationevidence.com/actions/2570>

● **Restore or create grassland**

Three studies evaluated the effects on mammals of restoring or creating grassland. One study each was in Portugal, the USA and Hungary.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A replicated, site comparison study in Hungary found that grassland restored on former cropland hosted a similar small mammal species richness compared to native grassland.

POPULATION RESPONSE (3 STUDIES)

Abundance (2 studies): A controlled, before-and-after study in Portugal found that sowing pasture grasses into areas cleared of scrub did not increase European rabbit densities. A replicated, site comparison study in Hungary found that grassland restored on former cropland hosted a similar abundance of small mammals compared to native grassland.

Survival (1 study): A replicated, site comparison study in the USA found that seeding with grassland species as part of a suite of actions including mechanical disturbance and herbicide application increased overwinter survival of mule deer fawns.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 40%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2566>

● Restore or create savannas

Two studies evaluated the effects on mammals of restoring or creating savannas. One study was in Senegal and one was in the USA.

COMMUNITY RESPONSE (1 STUDY)

Richness/diversity (1 study): A replicated, randomized, paired sites, controlled study in the USA found that restoring savannas by removing trees increased small mammal diversity.

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): A study in Senegal found that in a population of dorcas gazelle translocated into a fenced enclosure where vegetation had been restored, births outnumbered deaths. A replicated, randomized, paired sites, controlled study in the USA found that restoring savannas by removing trees did not, in most cases, change small mammal abundance.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 59%; certainty 50%; harms 0%).

<https://www.conservationevidence.com/actions/2568>

● Restore or create shrubland

Three studies evaluated the effects on mammals of restoring or creating shrubland. Two studies were in the USA and one was in Mexico.

COMMUNITY RESPONSE (2 STUDIES)

Richness/diversity (2 studies): Two site comparison studies, in the USA and Mexico, found that following desert scrub or shrubland restoration, mammal species richness was similar to that in undisturbed areas.

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A site comparison study in the USA found that restored desert scrub hosted similar small mammal abundance compared to undisturbed desert scrub.

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated, site comparison study in the USA found that restoring shrubland following tree clearance did not increase usage of areas by mule deer compared to tree clearance alone.

Assessment: likely to be beneficial (effectiveness 45%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2569>

Unknown effectiveness

● **Apply fertilizer to vegetation to increase food availability**

Two studies evaluated the effects on mammals of applying fertilizer to vegetation to increase food availability. One study was in Canada and one was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (2 STUDIES)

Use (2 studies): Two replicated, controlled studies, in Canada and the USA, found that applying fertilizer increased the use of vegetation by pronghorns and Rocky Mountain elk.

Assessment: unknown effectiveness (effectiveness 60%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2577>

● **Manage vegetation using grazing by wild herbivores**

Two studies evaluated the effects on mammals of managing vegetation using grazing by wild herbivores. One study was in the USA and one was in South Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): A site comparison study in the USA found that areas with higher numbers of wild herbivore grazers hosted more small

mammals than did areas grazed by fewer wild herbivores. A study in South Africa found that grazing by Cape mountain zebras did not lead to a higher population of bontebok.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 43%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2548>

● **Manage wetland water levels for mammal species**

One study evaluated the effects of managing wetland water levels for mammal species. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A replicated, site comparison study in the USA found that managing wetland water levels to be higher in winter increased the abundance of muskrat houses.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 60%; certainty 21%; harms 0%).

<https://www.conservationevidence.com/actions/2574>

● **Provide more small artificial breeding sites rather than fewer large sites**

One study evaluated the effects on mammals of providing more small artificial breeding sites rather than fewer larger sites. This study was in Spain.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A replicated, controlled study in Spain found that smaller artificial warrens supported higher rabbit densities than did larger artificial warrens.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 60%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2595>

● **Restore or create wetlands**

Four studies evaluated the effects on mammals of restoring or creating wetlands. Three studies were in the USA and one was in the UK.

COMMUNITY RESPONSE (2 STUDIES)

Community composition (1 study): A site comparison study in the USA found that the composition of mammal species present differed between a

created and a natural wetland.

Richness/diversity (2 studies): Two site comparison studies (one replicated) in the USA, found that mammal species richness did not differ between created and natural wetlands.

POPULATION RESPONSE (2 STUDIES)

Abundance (1 study): A before-and-after study in the USA found that following marshland restoration, muskrat abundance increased.

Survival (1 study): A replicated, controlled, before-and-after study in the UK, found that water voles persisted better in wetlands that were partially restored using mechanical or manual methods than they did in wetlands undergoing complete mechanical restoration.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 59%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2572>

Unlikely to be beneficial

● Remove vegetation using herbicides

Six studies evaluated the effects on mammals of removing vegetation using herbicides. All six studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (4 STUDIES)

Abundance (2 studies): Two controlled studies (one replicated) in the USA found that applying herbicide did not increase numbers of translocated Utah prairie dogs or alter mule deer densities in areas of tree clearance.

Survival (1 study): A replicated, site comparison study in the USA found that applying herbicide, along with mechanical disturbance and seeding, increased overwinter survival of mule deer fawns.

Condition (1 study): A replicated, controlled study in the USA found that applying herbicide did not reduce bot fly infestation rates of rodents and cottontail rabbits.

BEHAVIOUR (2 STUDIES)

Use (2 studies): Two replicated, controlled studies in the USA found that applying herbicide increased forest use by female, but not male, white-tailed deer and increased pasture use by cottontail rabbits in some, but not all, sampling seasons.

Assessment: unlikely to be beneficial (effectiveness 30%; certainty 42%; harms 19%).

<https://www.conservationevidence.com/actions/2565>



No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Remove topsoil that has had fertilizer added to mimic low nutrient soil
- Replant vegetation.

15.13 Species management

15.13.1 Translocate mammals

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for translocate mammals?	
Beneficial	<ul style="list-style-type: none">• Release translocated mammals into fenced areas• Translocate to re-establish or boost populations in native range
Likely to be beneficial	<ul style="list-style-type: none">• Hold translocated mammals in captivity before release• Provide supplementary food during/after release of translocated mammals• Translocate predators for ecosystem restoration• Use holding pens at release site prior to release of translocated mammals
Trade-off between benefit and harms	<ul style="list-style-type: none">• Translocate mammals to reduce overpopulation
Unknown effectiveness	<ul style="list-style-type: none">• Airborne translocation of mammals using parachutes• Use tranquilizers to reduce stress during translocation

Beneficial

● Release translocated mammals into fenced areas

Twenty-four studies evaluated the effects of releasing translocated mammals into fenced areas. Nine studies were in Australia, six studies were in South Africa, two studies were in the USA and one study was in each of India,

China, Spain, Hungary, Namibia and South Africa and France.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (22 STUDIES)

Abundance (5 studies): Five studies (one replicated) in the USA, Australia and South Africa found that following translocation into fenced areas, 18 African elephant populations, tule elk, brushtail possum and elk and bison increased in number and following eradication of invasive species a population of translocated and released captive-bred burrowing bettongs increased. A replicated, controlled study in Spain found that the abundance of translocated European rabbits was higher in areas fenced to exclude predators than unfenced areas.

Reproductive success (7 studies): Two replicated, controlled studies in France and Spain found that after translocation, reproductive success of common hamsters and European rabbits was higher inside than outside fenced areas or warrens. Four studies (one replicated, controlled) in China and South Africa found that following translocation into a fenced area, Père David's deer, lions, translocated and captive-bred African wild dogs and one of two groups of Cape buffalo reproduced. A study in Australia found that four of five mammal populations released into a predator-free enclosure and one population released into a predator-reduced enclosure reproduced, whereas two populations released into an unfenced area with ongoing predator management did not survive to breed.

Survival (13 studies): Two replicated, controlled studies in Spain and France found that after translocation, survival rates of common hamsters and European rabbits were higher inside than outside fenced areas or warrens. A study in Australia found that four of five mammal populations released into a predator-free enclosure and one population released into a predator-reduced enclosure survived, whereas two populations released into an unfenced area with ongoing predator management did not persist. Five studies in India, China, South Africa, Namibia and South Africa and Australia found that following translocation into fenced areas, most black rhinoceroses and greater Indian rhinoceroses, Père David's deer, most oribi and offspring of translocated golden bandicoots survived for between one and 10 years. Two studies in Australia found that only two of five translocated numbats survived over seven months and western barred bandicoots did not persist. A study in South Africa found that translocated and captive-bred African wild dogs released into fenced reserves in family groups had high survival rates. A study in Australia found that following release into fenced areas,

a translocated population of red-tailed phascogales survived longer than a released captive-bred population. A replicated, controlled study in South Africa found that after translocation to a fenced reserve with holding pens, survival of released lions was higher than that of resident lions.

Condition (3 studies): A replicated, before-and-after study in Australia found that eastern bettongs translocated into fenced predator proof enclosures increased in body weight post-release, with and without supplementary food. A replicated study in South Africa found that following translocation into fenced reserves, stress hormone levels of African elephants declined over time. A study in Australia found that golden bandicoots descended from a population translocated into a fenced area free from non-native predators, maintained genetic diversity relative to the founder and source populations.

BEHAVIOUR (2 STUDIES)

Use (2 studies): A site comparison study in Australia found that following translocation into a predator-free fenced area, woylies developed home ranges similar in size to those of an established population outside the enclosure. A study in Hungary found that one fifth of translocated European ground squirrels released into a fenced area with artificial burrows remained in the area after release.

Assessment: beneficial (effectiveness 80%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2467>

● **Translocate to re-establish or boost populations in native range**

Sixty-four studies evaluated the effects of translocating mammals to re-establish or boost populations in their native range. Twenty studies were in the USA, eight in Italy, four in Canada and South Africa, three in the Netherlands and Spain, two in each of the USA and Canada, Zimbabwe, Sweden, Australia and the USA and Mexico and one in each of Uganda, the UK, Brazil, France, Portugal, Africa, Europe, North America, Botswana, Nepal, Chile, Slovakia, Ukraine, Slovakia and Poland and one global study.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (62 STUDIES)

Abundance (22 studies): Two studies (including one controlled and one before-and-after, site comparison study) in Spain and Canada found that translocating animals increased European rabbit abundance or American badger population growth rate at release sites. Fourteen studies (one replicated) in South Africa, the USA, the Netherlands, Italy, France and Spain found

that following translocation, populations of warthogs, Eurasian beavers, red squirrels, roe deer, Alpine ibex, Iberian ibex, Cape mountain zebra, 22 species of grazing mammals, black bears, brown bear, bobcats and most populations of river otters increased. Two reviews in South Africa and Australia found that reintroductions (mainly through translocations) led to increasing populations for four of six species of large carnivores and that over half of translocations were classified as successful. One replicated study in the USA and Mexico found that translocating desert bighorn sheep did not increase the population size. Two studies (one replicated) and a review in USA and Canada, the USA and Australia found that translocated American martens, and sea otters at four of seven sites, established populations and that translocated and released captive-bred macropod species established populations in 44 of 72 cases. A study in Italy found that following the translocation of red deer, the density of Apennine chamois in the area almost halved. A worldwide review found that translocating ungulates was more successful when larger numbers were released, and small populations grew faster if they contained more mature individuals and had an equal ratio of males and females.

Reproductive success (16 studies): A controlled study in Italy found that wild-caught translocated Apennine chamois reproduced in similar numbers to released captive-bred chamois. Fourteen studies (four replicated) in Canada, the USA, Zimbabwe, South Africa, the UK, Italy, the Netherlands and Slovakia found that translocated black and white rhinoceroses, warthogs, common dormice, European ground squirrels, cougars, bobcats, brown bears, sea otters, river otters and some Eurasian otters reproduced. A study in the Netherlands found that translocated beavers were slow to breed.

Survival (39 studies): Four of five studies (including three controlled, two replicated and one before-and-after, site comparison study) in the USA, Canada and Chile found that wild-born translocated long-haired field mice, female elk, cougars and American badgers had lower survival rates than non-translocated resident animals. One found that translocated Lower Keys marsh rabbits had similar survival rates to non-translocated resident animals. Five of four studies (two replicated, four controlled) and two reviews in Canada, Canada and the USA, the USA, Italy, Sweden and Africa, Europe, and North America found that wild-born translocated swift foxes, European otters, black-footed ferret kits and a mix of carnivores had higher survival rates than released captive-bred animals. One study found that wild-born translocated Apennine chamois had a similar survival rate to released captive-bred animals. Twenty of twenty-one studies (including two replicated and

one before-and-after study) and a review in Nepal, France, Italy, Portugal, Ukraine, Slovakia and Poland, Canada, USA, Brazil, Uganda, South Africa, Zimbabwe and Botswana found that following translocation, populations of or individual mammals survived between two months and at least 25 years. The other two studies found that two of 10 translocated white rhinoceroses died within three days of release and an American marten population did not persist. A review in Australia found that over half of translocations, for which the outcome could be determined, were classified as successful. Two of three studies (one replicated) and one review in Sweden, the UK, the Netherlands and the USA and Mexico found that following release of wild-caught translocated and captive-bred animals, European otters and common dormice survived three months to seven years. The review found that most black-footed ferret releases were unsuccessful at maintaining a population. A replicated study in the USA found that following translocation of bighorn sheep, 48–98% of their offspring survived into their first winter.

Condition (3 studies): Three studies (including one replicated, controlled study) in the USA and Italy found that following translocation, populations of elk had similar levels of genetic diversity to non-translocated populations, descendants of translocated swift fox had genetic diversity at least as high as that of the translocated animals and brown bear genetic diversity declined over time.

BEHAVIOUR (9 STUDIES)

Use (7 studies): A study in Italy found that following translocation, Alpine ibex used similar habitats to resident animals. Two of four studies (including one randomized, controlled study) in the USA, Netherlands and Botswana found that following translocation (and in one case release of some captive-bred animals), most Eurasian otters settled and all three female grizzly bears established ranges at their release site. The other two studies found that most nine-banded armadillos and some white rhinoceroses (when released into areas already occupied by released animals) dispersed from their release site. Two studies (one replicated) in Spain found that following translocation, Iberian ibex expanded their range and roe deer increased their distribution six-fold. Behaviour change (2 studies): A replicated controlled study in Chile found that following translocation, long-haired field mice travelled two- to four-times further than non-translocated mice. A controlled study in Italy found that wild-caught translocated Apennine chamois moved further from the release site than released captive-bred animals.

Assessment: beneficial (effectiveness 75%; certainty 70%; harms 15%).

<https://www.conservationevidence.com/actions/2397>

Likely to be beneficial

● Hold translocated mammals in captivity before release

Fifteen studies evaluated the effects of holding translocated mammals in captivity before release. Four studies were in the USA, two were in Australia and one was in each of India, Canada, Switzerland, Croatia and Slovenia, the USA and Canada, the UK, France, Spain and South Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (13 STUDIES)

Abundance (2 studies): Two studies (one replicated, before-and-after study) in Croatia and Slovenia and the USA found that following translocation, with time in captivity prior to release, Eurasian lynx established an increasing population and Allegheny woodrat numbers in four of six sites increased over the first two years.

Reproductive success (4 studies): Four studies in Croatia and Slovenia, Spain, the USA and Canada and Australia found that following translocation, with time in captivity prior to release, Eurasian lynx established a breeding population, and swift foxes, European otters and red-tailed phascogales reproduced.

Survival (10 studies): Two studies (one controlled) in the UK and USA found that being held for longer in captivity before release increased survival rates of translocated European hedgehogs and, along with release in spring increased the survival rate of translocated Canada lynx in the first year. Four of six studies in India, the USA and Canada, the USA, France, South Africa and Australia found that following translocation, with time in captivity prior to release, most swift foxes and greater Indian rhinoceroses survived for at least 12-20 months, 48% of Eurasian lynx survived for 2-11 years and red-tailed phascogales survived for at least six years. The other two studies found that most kangaroo rats and all rock hyraxes died within 5-87 days. A replicated, controlled study in Canada found that translocated swift foxes that had been held in captivity prior to release had higher post-release survival rates than did released captive-bred animals.

Condition (3 studies): A randomised, controlled study in Australia found that holding translocated eastern bettongs in captivity before release did not increase their body mass after release compared to animals released directly into the wild. A controlled study the UK found that being held for longer in captivity before release, reduced weight loss after release in translocated European hedgehogs. A study in Spain found that offspring of translocated

European otters that were held in captivity before release, had similar genetic diversity to donor populations.

Occupancy/range (2 studies): A study in the USA found that most translocated and captive-bred mountain lions that had been held in captivity prior to release established home ranges in the release area. A study in Croatia and Slovenia and review in Switzerland found that following translocation, with time in captivity prior to release, the range of Eurasian lynx increased over time.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 60%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2458>

● **Provide supplementary food during/after release of translocated mammals**

Sixteen studies evaluated the effects of providing supplementary food during/after release of translocated mammals. Four studies were in the UK, two were in each of the USA, France, Australia and Argentina, and one was in each of Italy, Spain, Ireland and South Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (15 STUDIES)

Abundance (2 studies): A controlled study in Spain found that providing supplementary food during translocation did not increase European rabbit abundance. A study in France found that following supplementary feeding in a holding pen prior to release, a translocated deer population increased over six years.

Reproductive success (4 studies): Three studies (one replicated) in the USA, Italy and Ireland found that having been provided with supplementary food in holding pens prior to release, translocated black-tailed prairie dogs, a pair of Eurasian badgers and most female red squirrels reproduced in the wild. A study in the UK found that some translocated pine martens released from holding pens and then provided with supplementary food and nest boxes bred in the first year after release.

Survival (10 studies): Six of 10 studies (including one replicated and one controlled study) in the UK, France, Italy, Ireland, South Africa, USA, Argentina and Australia found that at sites with supplementary food in holding pens before (and in two cases after) release, translocated populations of black-tailed prairie dogs, approximately half of female roe deer and over half of red squirrels, Eurasian badgers, pine martens and released rehabilitated or captive reared giant anteaters survived for between one month and at least two

years. Four studies found that at translocation release sites with provision of supplementary food, in most cases artificial refuges and in one case water, no red squirrels, rock hyraxes or burrowing bettongs survived over 2-5 months and most translocated Tipton and Heermann's kangaroo rat spp. died within five days. A controlled study in France found that translocated European rabbits provided with supplementary food in holding pens for three days prior to release had higher female (but not male) survival rates immediately following release compared to those released directly. A controlled study in the UK found that survival of translocated and rehabilitated European hedgehogs that were provided with supplementary food after release varied with release method.

Condition (2 studies): One of three studies (including one replicated, one controlled and two before-and-after studies) in the UK and Australia found that translocated common dormice gained weight after being provided with supplementary food. One found that translocated eastern bettongs did not have increased body weights after provision of supplementary food in fenced enclosures prior to release. The other found that translocated and rehabilitated European hedgehogs provided with food after release all lost body mass, with effects varying with release method.

BEHAVIOUR (2 STUDIES)

Use (1 study): A controlled study in Australia found that supplementary feeding stations were visited by translocated burrowing bettongs.

Behaviour change (1 study): A controlled study in Argentina found that after being provided with supplementary food and kept in holding pens, released captive-bred giant anteaters were less nocturnal than wild-born rehabilitated and released individuals.

Assessment: likely to be beneficial (effectiveness 67%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2470>

● Translocate predators for ecosystem restoration

Two studies evaluated the effects of translocating predators for ecosystem restoration. These studies were in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Abundance (2 studies): A before-and-after study in the USA found that following reintroduction of wolves, populations of beavers and bison increased. A before-and-after study in the USA found that after the translocation of wolves to the reserve, adult elk numbers approximately halved.

Reproductive success (1 study): A before-and-after study in the USA found that after the translocation of wolves to the reserve, elk calf:cow ratios approximately halved.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 70%; certainty 55%; harms 10%).

<https://www.conservationevidence.com/actions/2431>

● Use holding pens at release site prior to release of translocated mammals

Thirty-five studies evaluated the effects of using holding pens at the release site prior to release of translocated mammals. Ten studies were in the USA, seven were in South Africa, four were in the UK, three studies were in France, two studies were in each of Canada, Australia and Spain and one was in each of Kenya, Zimbabwe, Italy, Ireland and India.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (31 STUDIES)

Abundance (4 studies): Three of four studies (two replicated, one before-and-after study) in South Africa, Canada, France and Spain found that following release from holding pens at release sites (in some cases with other associated actions), populations of roe deer, European rabbits and lions increased in size. The other study found that elk numbers increased at two of four sites.

Reproductive success (10 studies): A replicated study in the USA found that translocated gray wolves had similar breeding success in the first two years after release when adult family groups were released together from holding pens or when young adults were released directly into the wild. Seven of nine studies (including two replicated and one controlled study) in Kenya, South Africa, the USA, Italy, Ireland, Australia and the UK found that following release from holding pens at release sites (in some cases with other associated actions), translocated populations of roan, California ground squirrels, black-tailed prairie dogs, lions, four of four mammal populations, most female red squirrels and some pine martens reproduced successfully. Two studies found that one of two groups of Cape buffalo and one pair out of 18 Eurasian badgers reproduced.

Survival (26 studies): Two of seven studies (five controlled, three replicated studies) in Canada, the USA, France, the UK found that releasing animals from holding pens at release sites (in some cases with associated actions) resulted in higher survival for water voles and female European rabbits

compared to those released directly into the wild. Four studies found that translocated swift foxes, gray wolves, Eurasian lynx and Gunnison's prairie dogs released from holding pens had similar survival rates to those released directly into the wild. One study found that translocated American martens released from holding pens had lower survival than those released directly into the wild. Two of four studies (three controlled) in South Africa, Spain, and the USA found that translocated African wild dogs and European rabbits that spent longer in holding pens at release sites had a higher survival rate after release. One study found mixed effects for swift foxes and one found no effect of time in holding pens for San Joaquin kit foxes. Eleven studies (one replicated) in Kenya, South Africa, the USA, France, Italy, Ireland, India, Australia and the UK found that after release from holding pens at release sites (in some cases with other associated actions), translocated populations or individuals survived between one month and six years, and four of four mammal populations survived. Two studies in the UK and South Africa found that no released red squirrels or rock hyraxes survived over five months or 18 days respectively. One of two controlled studies (one replicated, one before-and-after) in South Africa and the USA found that following release from holding pens, survival of translocated lions was higher than that of resident animals, whilst that of translocated San Joaquin kit foxes was lower than that of resident animals. A study in Australia found that translocated bridled nailtail wallabies kept in holding pens prior to release into areas where predators had been controlled had similar annual survival to that of captive-bred animals.

Condition (1 study): A controlled study in the UK found that translocated common dormice held in pens before release gained weight after release whereas those released directly lost weight.

BEHAVIOUR (5 STUDIES)

Behaviour change (5 studies): Three studies (one replicated) in the USA and Canada found that following release from holding pens, fewer translocated sea otters and gray wolves returned to the capture site compared to those released immediately after translocation, and elk remained at all release sites. Two studies in Zimbabwe and South Africa found that following release from holding pens, translocated lions formed new prides.

Assessment: likely to be beneficial (effectiveness 72%; certainty 60%; harms 10%).

<https://www.conservationevidence.com/actions/2434>

Trade-off between benefit and harms

● **Translocate mammals to reduce overpopulation**

Three studies evaluated the effects of translocating mammals to reduce overpopulation. Two studies were in the USA and one was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Abundance (1 study): A before-and-after study in the USA found that adult elk numbers approximately halved after the translocation of wolves to the reserve.

Reproductive success (1 study): A before-and-after study in the USA found that elk calf:cow ratios approximately halved after the translocation of wolves to the reserve.

Survival (2 studies): A study in Australia found that koalas translocated to reduce overpopulation had lower survival than individuals in the source population. A study in the USA found that following translocation to reduce over-abundance, white-tailed deer had lower survival rates compared to non-translocated deer at the recipient site.

Occupancy/range (1 study): A study in the USA found that following translocation to reduce over-abundance at the source site, white-tailed deer had similar home range sizes compared to non-translocated deer at the recipient site.

BEHAVIOUR (0 STUDIES)

Assessment: trade-off between benefit and harms (effectiveness 66%; certainty 47%; harms 20%).

<https://www.conservationevidence.com/actions/2430>

Unknown effectiveness

● **Airborne translocation of mammals using parachutes**

One study evaluated the effects of airborne translocation of mammals using parachutes. This study was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A study in the USA found that at least some North American beavers translocated using parachutes established territories and survived over one year after release.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 50%; certainty 24%; harms 15%).

<https://www.conservationevidence.com/actions/2466>

● **Use tranquilizers to reduce stress during translocation**

One study evaluated the effects on mammals of using tranquilizers to reduce stress during translocation. This study was in France.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A controlled study in France found that using tranquilizers to reduce stress during translocation did not increase post-release survival of European rabbits.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 10%; certainty 15%; harms 10%).

<https://www.conservationevidence.com/actions/2465>

15.13.2 Captive-breeding

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for captive-breeding?	
Beneficial	<ul style="list-style-type: none"> • Breed mammals in captivity
Likely to be beneficial	<ul style="list-style-type: none"> • Use artificial insemination
Unknown effectiveness	<ul style="list-style-type: none"> • Clone rare species • Place captive young with captive foster parents • Preserve genetic material for use in future captive breeding programs

Beneficial

● **Breed mammals in captivity**

Three studies evaluated the effects of breeding mammals in captivity. One study was across Europe, one was in the USA and one was global.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Abundance (1 study): A review of captive-breeding programmes across the world found that the majority of 118 captive-bred mammal populations increased.

Reproductive success (2 studies): A review of a captive breeding programme across Europe found that the number of European otters born in captivity tended to increase over 15 years. A study in the USA found that wild-caught Allegheny woodrats bred in captivity.

Survival (1 study): A review of a captive breeding programme across Europe found that the number of European otters born in captivity that survived tended to increase over 15 years.

BEHAVIOUR (0 STUDIES)

Assessment: beneficial (effectiveness 80%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2471>

Likely to be beneficial

● Use artificial insemination

Three studies evaluated the effects on mammals of using artificial insemination. One study was in the USA, one was in Brazil and one was in China.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Reproductive success (3 studies): A study in the USA found that following artificial insemination, fewer than half of female black-footed ferrets gave birth. A study in Brazil found that following artificial insemination, a captive female Amazonian brown brocket deer gave birth. A replicated study in China found that following artificial insemination, a lower proportion of captive female giant pandas became pregnant than after natural mating.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 40%; certainty 40%; harms 9%).

<https://www.conservationevidence.com/actions/2473>

Unknown effectiveness

● Clone rare species

One study evaluated the effects of cloning rare species. This study was in Iran.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Reproductive success (1 study): A controlled study in Iran found that immature eggs of domestic sheep have potential to be used for cloning of Esfahan mouflon.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 40%; certainty 20%; harms 10%).

<https://www.conservationevidence.com/actions/2474>

● Place captive young with captive foster parents

Two studies evaluated the effects of placing captive young mammals with captive foster parents. One study was in the USA and one was in Sweden and Norway.

COMMUNITY RESPONSE (0 STUDIES)**POPULATION RESPONSE (2 STUDIES)**

Survival (2 studies): A replicated, controlled study in the USA found that most captive coyote pups placed with foster parents were successfully reared. A replicated study in Sweden and Norway found that captive grey wolf pups placed with foster parents had higher survival rates than pups that stayed with their biological mother.

Condition (1 study): A replicated study in Sweden and Norway found that captive grey wolf pups placed with foster parents weighed less than pups that stayed with their biological mother.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 70%; certainty 32%; harms 10%).

<https://www.conservationevidence.com/actions/2472>

● Preserve genetic material for use in future captive breeding programs

Two studies evaluated the effects of preserving genetic material for use in future captive breeding programs. One study was in Mexico and one was in the USA.

COMMUNITY RESPONSE (0 STUDIES)**POPULATION RESPONSE (2 STUDIES)**

Survival (2 studies): A study in Mexico found that a series of non-traditional techniques, combined with natural mating, produced five aoudad embryos that could be cryogenically preserved. A study in USA, found that artificial insemination using preserved genetic material increased genetic diversity and lowered inbreeding in a captive black-footed ferret population.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 60%; certainty 35%; harms 0%).

<https://www.conservationevidence.com/actions/2475>

15.13.3 Release captive-bred mammals

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for release captive-bred mammals?	
Beneficial	<ul style="list-style-type: none">• Provide supplementary food during/after release of captive-bred mammals• Release captive-bred individuals to re-establish or boost populations in native range• Release captive-bred mammals into fenced areas• Use holding pens at release site prior to release of captive-bred mammals
Likely to be beneficial	<ul style="list-style-type: none">• Captive rear in large enclosures prior to release• Provide live natural prey to captive mammals to foster hunting behaviour before release
Unknown effectiveness	<ul style="list-style-type: none">• Train captive-bred mammals to avoid predators

Beneficial

● Provide supplementary food during/after release of captive-bred mammals

Fifteen studies evaluated the effects of providing supplementary food during/after release of captive-bred mammals. Four studies were in Australia, two were in each of the USA, China and Argentina, and one was in each of Poland, the UK, Oman and Saudi Arabia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (14 STUDIES)

Abundance (5 studies): Four studies (one replicated, one before-and-after study) and one review in Poland, Oman, China and Australia found that following provision of supplementary food (and in one case water) to released captive-bred animals, populations of European bison increased more than

six-fold over 20 years, Arabian oryx increased over 14 years, eastern-barred bandicoots increased for the first five years before declining, Père David's deer increased more than six-fold over 12 years and Przewalski's horses (enclosed in winter) increased over 11 years.

Reproductive success (9 studies): Eight studies (including two replicated and one before-and-after study) and one review in Poland, the UK, China, the USA, Australia and Saudi Arabia found that following the provision of supplementary food (and in one case water or artificial nests) after release of captive-bred animals, some from holding pens, European bison, European otters, Père David's deer, eastern-barred bandicoots, Przewalski's horses and some captive-bred red wolves successfully reproduced, Arabian gazelles started breeding in the year following releases and sugar gliders established a breeding population.

Survival (6 studies): Four of six studies (one controlled, before-and-after study) in the UK, USA, Argentina and Australia found that following the provision of supplementary food (and in one case water or nest boxes) after release of captive-bred animals, many from holding pens, 19% of red wolves survived for at least seven years, Eurasian otters survived for at least two years, over half the giant anteaters (some rehabilitated) survived for at least six months and hare-wallabies survived at least two months. Two of the studies found that red-tailed phascogales survived for less than a year and most Mexican wolves survived less than eight months.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A controlled study in Argentina found that after being provided with supplementary food and kept in holding pens, released captive-bred giant anteaters were less nocturnal in their activity patterns than released wild-born rehabilitated individuals.

Assessment: beneficial (effectiveness 72%; certainty 70%; harms 10%).

<https://www.conservationevidence.com/actions/2527>

● **Release captive-bred individuals to re-establish or boost populations in native range**

Thirty-one studies evaluated the effects of releasing captive-bred mammals to establish or boost populations in their native range. Seven studies were in the USA, three were in Australia and Italy, two studies were in each of Canada, Sweden, Saudi Arabia, the UK, the Netherlands and South Africa and one study was in each of France, Africa, Europe, and North America, Estonia, the USA and Mexico, Poland and China.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (30 STUDIES)

Abundance (7 studies): Five of five studies (one replicated) and two reviews in Saudi Arabia, Australia, the USA, South Africa, France, the Netherlands and China found that following release of captive-bred (or in one case captive-reared, or including translocated) animals, populations of mountain gazelles, Corsican red deer, Père David's deer, Eurasian otters and swift foxes increased. The two reviews found that following release of mainly translocated but some captive-bred large carnivores, populations of four of six species increased, and over half of mammal release programmes were considered successful.

Reproductive success (5 studies): Four studies (one replicated) in Saudi Arabia, the UK and the Netherlands found that released captive-bred (and in some cases some wild-born translocated) mountain gazelles, dormice and some Eurasian otters reproduced successfully and female Arabian oryx reproduced successfully regardless of prior breeding experience. A controlled study in Italy found that released captive-born Apennine chamois reproduced in similar numbers to wild-caught translocated chamois.

Survival (24 studies): Four of three controlled studies (two replicated) and two reviews in Canada, Canada and the USA, Sweden, Italy and across the world found that released captive-bred swift foxes, European otters and mammals from a review of 49 studies had lower post-release survival rates than did wild-born translocated animals. The other study found that released captive-born Apennine chamois survived in similar numbers to wild-caught translocated chamois. Three studies (one replicated) in the USA and Canada found that released captive-born Key Largo woodrats, Vancouver Island marmots and swift fox pups had lower survival rates than wild-born, wild-living animals. One of the studies also found that Vancouver Island marmots released at two years old were more likely to survive than those released as yearlings. Eleven studies (three replicated) in Italy, Sweden, the UK, Estonia, Poland, Saudi Arabia, Australia and the USA found that following the release of captive-bred (and in some cases some wild-born translocated) animals, Arabian oryx, populations of European otters, European mink and mountain gazelle survived for 2-11 years, roe deer and over a third of brush-tailed rock-wallabies, black-footed ferrets and brown hares survived for 0.5-24 months and dormice populations survived three months to over seven years. A review in Australia found that release programmes for macropod species resulted in successful establishment of populations in 61% of cases and that

40% survived over five years, and another review in Australia found that over half of programmes were considered successful. Two studies and a review in the USA, USA and Mexico and South Africa found that over 40% of released captive-bred American black bears were killed or had to be removed, only one of 10 oribi survived over two years and that most black-footed ferret releases were unsuccessful at maintaining a population.

BEHAVIOUR (3 STUDIES)

Use (3 studies): Two studies in the USA and Australia found that following release, most captive-bred and translocated mountain lions that had been held in captivity prior to release and most released captive-bred brush-tailed rock-wallabies established stable home ranges. A controlled study in Italy found that released captive-born Apennine chamois remained closer to the release site than released wild-caught translocated chamois.

Assessment: beneficial (effectiveness 70%; certainty 67%; harms 10%).

<https://www.conservationevidence.com/actions/2476>

● Release captive-bred mammals into fenced areas

Fourteen studies evaluated the effects of releasing captive-bred mammals into fenced areas. Nine studies were in Australia and one each was in Jordan, South Africa, the USA, Saudi Arabia and Senegal.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (14 STUDIES)

Abundance (5 studies): Four studies (one replicated) and a review in Australia, Jordan and Senegal found that after releasing captive-bred animals into fenced areas, a population of burrowing bettongs increased, a population of Arabian oryx increased six-fold in 12 years, a population of dorcas gazelle almost doubled over four years, three populations of eastern barred bandicoot initially increased and abundance of eastern barred bandicoots increased.

Reproductive success (6 studies): Four studies and a review in South Africa, Australia, Saudi Arabia and Senegal found that following release of captive-bred animals into fenced areas (in some cases with other associated management), African wild dogs, three populations of eastern barred bandicoot, dorcas gazelle and most female black-footed rock-wallabies reproduced, and Arabian gazelles started breeding in the year following the first releases. A study in Australia found that four of five mammal populations released into a predator-free enclosure and one released into a predator-reduced enclosure reproduced, whereas two populations released into an unfenced area with ongoing predator management did not survive to reproduce.

Survival (10 studies): A study in Australia found that four of five mammal populations released into a predator-free enclosure and one population released into a predator-reduced enclosure survived, whereas two populations released into an unfenced area with ongoing predator management did not. Six studies (one controlled before-and-after study and two replicated studies) in Australia and the USA found that following release of captive-bred animals into fenced areas (in some cases with other associated management), a burrowing bettong population, three eastern barred bandicoot populations and over half of black-footed rock-wallabies survived between one and eight years, most captive-bred hare-wallabies survived at least two months, at least half of black-footed ferrets survived more than two weeks, and bandicoots survived at five of seven sites up to three years after the last release. One study in Australia found that following release into fenced areas, a captive-bred population of red-tailed phascogales survived for less than a year. A study in South Africa found that captive-bred African wild dogs released into fenced reserves in family groups had high survival rates. A randomized, controlled study in Australia found that captive-bred eastern barred bandicoots released into a fenced reserve after time in holding pens had similar post-release survival compared to bandicoots released directly from captivity. **Condition (1 study):** A randomized, controlled study in Australia found that captive-bred eastern barred bandicoots released into a fenced reserve after time in holding pens had similar post-release body weight compared to those released directly from captivity.

BEHAVIOUR (0 STUDIES)

Assessment: beneficial (effectiveness 77%; certainty 70%; harms 0%).

<https://www.conservationevidence.com/actions/2521>

● **Use holding pens at release site prior to release of captive-bred mammals**

Thirty-one studies evaluated the effects of using holding pens at the release site prior to release of captive-bred mammals. Seven studies were in Australia, and in the USA, four were in the UK, three in Argentina, two in each of Israel, Saudi Arabia and China and one in each of Canada, Namibia, South Africa and Germany.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (30 STUDIES)

Abundance (2 studies): A study in Saudi Arabia found that a population of captive-bred Arabian sand gazelles kept in holding pens prior to release

nearly doubled in size over four years. A before-and-after study in China found that following release of captive-bred animals from a pre-release enclosure into the semi-wild (free-roaming in summer, enclosed in winter and provided with food), Przewalski's horses increased in number.

Reproductive success (10 studies): Eight studies (one replicated) and one review in the UK, Saudi Arabia, the USA, Israel and Australia found that following the use of holding pens prior to release (and in some cases provision of supplementary food), captive-bred Eurasian otters, Arabian sand gazelles, eastern-barred bandicoots, some swift foxes, some red wolves and over 33% of Persian fallow deer reproduced, Arabian gazelles started breeding in the first year and the reproductive success of female Asiatic wild ass increased over 10 years. A study in Australia found that after being kept in a holding pen, all four mammal populations released into an invasive-species-free fenced enclosure reproduced.

Survival (23 studies): One of three studies (two controlled, one replicated) in the UK, Canada and Australia found that using holding pens prior to release of captive-bred (and some translocated) animals resulted in greater post-release survival for water voles compared to animals released directly into the wild. The other two studies found similar survival rates for eastern barred bandicoots and swift foxes compared to animals released directly into the wild. A replicated study in the USA found that captive-bred Allegheny woodrats kept in holding pens prior to release, had higher early survival rates than those not kept in holding pens, but overall survival rates tended to be lower than wild resident woodrats. Three studies in South Africa, USA and Argentina found that released captive-bred (and some translocated) African wild dogs, riparian brush rabbits and guanacos that spent longer in, and in one case in larger, holding pens had a higher survival rate. Three studies (one controlled) in Australia and the USA found that captive-bred animals kept in holding pens prior to release had similar (bridled nailtail wallabies) or lower (black-footed ferret kits) annual survival rate after release to that of wild-born translocated animals and lower (black-footed ferrets) survival rates than resident animals. Ten studies (including one controlled, before-and-after study) and one review in Saudi Arabia, the USA, Argentina, China, Israel, Australia and Germany found that following the use of holding pens prior to release of captive-bred animals (or in some cases captive-reared/rehabilitated, or with provision of supplementary food), four of four mammal populations, 19% of red wolves, Asiatic wild ass, Persian fallow deer, most Arabian sand gazelles, most swift foxes, eastern-barred bandicoots and European mink

survived at least 1-10 years, over half of giant anteaters, hare-wallabies and Père David's deer survived for at least 1.5-6 months. Three studies in Namibia, the USA and Australia found that following the use of holding pens prior to release of captive-bred or reared animals (some provided with nest boxes and/or supplementary food), red-tailed phascogales, most Mexican wolves and African wild dogs survived less than 6-12 months.

Condition (4 studies): A randomized, controlled study in Australia found that eastern barred bandicoots released after time in holding pens lost a similar proportion of body weight and recovered to a similar weight compared to bandicoots released directly. A controlled study in the UK found that common dormice lost weight after being put into holding pens whereas wild translocated dormice gained weight. A controlled, before-and-after study in Australia found that captive-bred rufous hare-wallabies placed in holding pens prior to release lost body condition in holding pens. A before-and-after study in Australia found that captive-bred brush-tailed rock-wallabies placed in a holding pen prior to release maintained good health.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A controlled study in Argentina found that after being kept in holding pens and provided with supplementary food, released captive-bred giant anteaters were less nocturnal in their activity patterns than released wild-born rehabilitated individuals.

Assessment: beneficial (effectiveness 70%; certainty 65%; harms 10%).

<https://www.conservationevidence.com/actions/2510>

Likely to be beneficial

● Captive rear in large enclosures prior to release

Four studies evaluated the effects of captive rearing mammals in large enclosures prior to release. Two studies were in the USA, one was in Mexico and one was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Reproductive success (1 study): A study in Mexico found that peninsular pronghorn taken from the wild and kept in a large enclosure bred successfully and the population increased, providing stock suitable for reintroductions.

Survival (2 studies): A replicated, controlled study in USA found that black-footed ferrets reared in outdoor pens had higher post-release survival rates than did ferrets raised indoors. A controlled study in Australia found that

Tasmanian devils reared free-range in large enclosures did not have greater post-release survival rates than animals from intensively managed captive-rearing facilities.

Condition (1 study): A controlled study in Australia found that Tasmanian devils reared free-range in large enclosures did not gain more body weight post-release compared to animals from intensively managed captive-rearing facilities.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A controlled study in USA found that captive-bred black-footed ferrets raised in large enclosures dispersed shorter distances post-release than did ferrets raised in small enclosures.

Assessment: likely to be beneficial (effectiveness 50%; certainty 46%; harms 0%).

<https://www.conservationevidence.com/actions/2507>

● Provide live natural prey to captive mammals to foster hunting behaviour before release

Three studies evaluated the effects of providing live natural prey to captive mammals to foster hunting behaviour before release. One study was in Spain, one was in the USA and one was in Botswana.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (2 STUDIES)

Survival (2 studies): Two studies in Spain and Botswana found that a rehabilitated Iberian lynx and wild-born but captive-reared orphaned cheetahs and leopards that were provided with live natural prey in captivity survived for between at least three months and 19 months after release.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A controlled study in the USA found that captive-bred black-footed ferrets fed on live prairie dogs took longer to disperse after release but showed greater subsequent movements than did ferrets not fed with live prairie dogs.

Assessment: likely to be beneficial (effectiveness 65%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2518>

Unknown effectiveness

● Train captive-bred mammals to avoid predators

Two studies evaluated the effects of training captive-bred mammals to avoid predators. One study was in Australia and one was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A randomized, controlled study in the USA found that training captive-born juvenile black-tailed prairie dogs, by exposing them to predators, increased post-release survival.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A before-and-after study in Australia found that rufous hare-wallabies could be conditioned to become wary of potential predators.

Assessment: unknown effectiveness (effectiveness 70%; certainty 37%; harms 0%).

<https://www.conservationevidence.com/actions/2520>

15.13.4 Release captive-bred/translocated mammals

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for release captive-bred/translocated mammals?	
Beneficial	<ul style="list-style-type: none">• Release translocated/captive-bred mammals in areas with invasive/problematic species eradication/control• Release translocated/captive-bred mammals in family/social groups• Release translocated/captive-bred mammals into area with artificial refuges/breeding sites
Likely to be beneficial	<ul style="list-style-type: none">• Release translocated/captive-bred mammals at a specific time (e.g. season, day/night)• Release translocated/captive-bred mammals in larger unrelated groups• Release translocated/captive-bred mammals to areas outside historical range• Release translocated/captive-bred mammals to islands without invasive predators

Beneficial

● Release translocated/captive-bred mammals in areas with invasive/problematic species eradication/control

Twenty-two studies evaluated the effects of releasing translocated or captive-bred mammals in areas with eradication or control of invasive or problematic species. Sixteen studies were in Australia, four were in the USA, and one in the UK.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (21 STUDIES)

Abundance (4 studies): A replicated study in Australia found that increasing amounts of regular predator control increased population numbers of released captive-bred eastern barred bandicoots. Two studies in Australia found that following eradication or control of invasive species, a population of translocated and released captive-bred burrowing bettongs increased and a population of translocated western barred bandicoots increased over four years. A study in Australia found that following the release of captive-bred bridled nailtail wallabies and subsequent predator controls, numbers increased over a three years, but remained low compared to the total number released. Reproductive success (2 studies): A study in Australia found that four of five captive-bred mammal populations released into a predator-free enclosure and one population released into a predator-reduced enclosure produced a second generation, whereas two populations released into an unfenced area with ongoing predator management did not survive to reproduce. A study in Australia found that most female captive-reared black-footed rock-wallabies released into a large predator-free fenced area reproduced.

Survival (18 studies): Ten studies (one controlled, three replicated, two before-and-after studies) in Australia, and the UK found that following the eradication/control of invasive species (and in some cases release into a fenced area), a translocated population of woylies, western barred bandicoots and red-tailed phascogales survived over four years, released captive-bred eastern barred bandicoots survived up to three years at five of seven sites, offspring of translocated golden bandicoots survived three years, over half of released captive-reared black-footed rock-wallabies survived over two years, captive-bred water voles survived for at least 20 months or over 11 months at over half of release sites, most released captive-bred hare-wallabies survived at least two months, most captive-bred eastern barred bandicoots survived for over three weeks. A replicated study in Australia found that after

the control of invasive species, four translocated populations of burrowing bettongs died out within four months. A review of studies in Australia found that in seven studies where red fox control was carried out before or after the release of captive-bred eastern-barred bandicoots, survival varied. A study in Australia found that four of five captive-bred mammal populations released into a predator-free enclosure and one population released into a predator-reduced enclosure survived, whereas two populations released into an unfenced area with ongoing predator management did not. A study in Australia found that captive-bred bridled nailtail wallabies released from holding pens in areas where predators had been controlled had similar annual survival rates to that of wild-born translocated animals. Two studies (one replicated) in the USA found that where predators were managed, at least half of released captive-bred black-footed ferrets survived more than two weeks, but that post-release mortality was higher than resident wild ferrets. A before-and-after study in the USA found following the onset of translocations of black bears away from an elk calving site, survival of the offspring of translocated elk increased.

Condition (2 studies): A study Australia found that wild-born golden bandicoots, descended from a translocated population released into a predator-free enclosure, maintained genetic diversity relative to the founder and source populations. A replicated, before-and-after study in Australia found that one to two years after release into predator-free fenced reserves, translocated eastern bettongs weighed more and had improved nutritional status compared to before release.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A replicated, before-and-after study in the USA found that translocated Utah prairie dogs released after the control of native predators into an area with artificial burrows showed low site fidelity and different pre- and post-release behaviour.

Assessment: beneficial (effectiveness 69%; certainty 62%; harms 10%).

<https://www.conservationevidence.com/actions/2469>

● **Release translocated/captive-bred mammals in family/ social groups**

Twenty-six studies evaluated the effects of releasing translocated or captive-bred mammals in family or social groups. Eleven were in the USA, seven were in South Africa and one was in each of Poland, Zimbabwe, along the USA–Canada border, Russia, Italy, Canada, China and India.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (22 STUDIES)

Abundance (4 studies): A study in the USA found that a translocated population of Rocky Mountain bighorn sheep released in groups increased at a similar rate to that of a population newly established through natural recolonization. A replicated, controlled study in the USA found that after translocating black-tailed prairie dogs in social groups to areas with artificial burrows, colonies increased in size over four years. A replicated study in Canada found that following translocation of elk, most of which had been kept in holding pens in groups, numbers increased at two of four sites. A study in the USA found that following the release of captive-reared bighorn sheep in groups, the overall population declined over 14 years.

Reproductive success (11 studies): A study in the USA found that captive-reared bighorn sheep released in groups had similar population recruitment rates compared to wild-reared sheep. A replicated, paired study in the USA found that black-tailed prairie dogs translocated as family groups had higher reproductive success than those translocated in non-family groups. A replicated study in the USA found that translocated gray wolves had similar breeding success when adult family groups were released together from holding pens or when young adults were released directly into the wild. Six of eight studies (one replicated) in Poland, Russia, South Africa, the USA and the USA–Canada border found that when translocated and/or captive-bred animals were released in social or family groups, cheetahs, European bison, lions, African wild dogs, most European beavers and some swift foxes reproduced successfully. One study found that one of two translocated Cape buffalo groups released after being held in a holding pen formed a single herd and reproduced, while the other scattered and escaped the reserve. One study found that no Gunnison's prairie dogs reproduced during the first year.

Survival (19 studies): One of three studies (one controlled, before-and-after) in the USA found that when translocated or captive-bred animals were released in family or social groups, captive-reared bighorn sheep had similar survival compared to wild-reared sheep, whereas two found lower survival compared to wild white-tailed deer and San Joaquin kit foxes. Three replicated studies (one controlled, one paired) in the USA found that when translocated as a social or family group, black-tailed prairie dogs had higher and white-tailed deer and gray wolves had similar survival rates to those translocated as unrelated groups or individuals. Ten studies (one replicated)

in Poland, Russia, Italy, South Africa, the USA, USA–Canada border, China and India found that when translocated and/or captive-bred animals were released in social or family groups, a population of Przewalski's horses and European bison persisted 5-11 years, lions, most swift foxes and European beavers and half or more cheetahs survived for at least one year, and one-horned rhinoceroses and over half of Gunnison's prairie dogs and Eurasian badgers survived at least 1-6 months. Three studies in the USA and South Africa found that when translocated or captive-bred animals were released in family or social groups (some provided with artificial refuges and/or supplementary food), most Mexican wolves did not survive over eight months and all rock hyraxes died within 90 days. A study in South Africa found that translocated and captive-bred African wild dogs released in family groups into fenced reserves had high survival rates.

Condition (1 study): A study in China found that following the release of captive-bred Przewalski's horses in groups, the population had a lower genetic diversity than two captive populations.

BEHAVIOUR (4 STUDIES)

Behaviour change (4 studies): Two replicated, controlled (one before-and-after) studies in the USA found that when translocated as a social or family group, white-tailed deer had similar average dispersal distances and Utah prairie dogs had similar release site fidelity and post-release behaviour compared to those translocated as unrelated groups. One found that deer translocated together did not stay together, whether they had previously been part of the same social group or not. A study in Zimbabwe found that a translocated lion family joined with immigrant lions and formed a new pride. A study in South Africa found that translocated lions that were released in groups that had already been socialised and formed into prides, established stable home ranges.

Assessment: beneficial (effectiveness 70%; certainty 65%; harms 5%).

<https://www.conservationevidence.com/actions/2463>

● **Release translocated/captive-bred mammals into area with artificial refuges/breeding sites**

Seventeen studies evaluated the effects of releasing translocated or captive-bred mammals into areas with artificial refuges or breeding sites. Five studies were in the USA, three were in Australia, three were in Spain, two were in the UK and one was in each of Ireland, South Africa, Hungary and Slovakia, the Czech Republic and Poland.

COMMUNITY RESPONSE (0 STUDIES)**POPULATION RESPONSE (15 STUDIES)**

Abundance (5 studies): Two of three studies (two replicated, two controlled) in Spain and the USA found that translocation release sites with artificial burrows provided had higher abundances of European rabbits and densities of California ground squirrels compared to those without. The other study found that abundance of European rabbits following translocation was similar with and without artificial burrows provided. A replicated, controlled study in the USA found that after translocating black-tailed prairie dogs to areas with artificial burrows, colonies increased in size. A before-and-after study in Spain found that translocating European rabbits into areas with artificial refuges to supplement existing populations did not alter rabbit abundance, although two of three populations persisted for at least three years.

Reproductive success (4 studies): Three studies in Australia, Ireland and the UK found that released captive-bred sugar gliders, most translocated female red squirrels and some translocated pine martens provided with nest boxes and supplementary food reproduced. A study of 12 translocation projects in Slovakia, the Czech Republic and Poland found that translocated European ground squirrels released initially into enclosures or burrows with retention caps reproduced after release, whereas those without enclosures or burrows dispersed from release sites.

Survival (9 studies): Five of eight studies in Australia, the USA, UK, Ireland and South Africa found that at release sites with artificial refuges, and in some cases food provided, a population of captive-bred sugar gliders survived at least three years, two of three populations of red-tailed phascogales survived for more than four years, most translocated black bears survived at least one year and over half translocated red squirrels and pine martens survived 8-12 months. Three studies found that at release sites with artificial refuges, food and in one case water provided, no translocated red squirrels survived more than five months, all translocated rock hyraxes died within three months and most translocated Tipton and Heermann's kangaroo rat spp. died within five days. A randomised, replicated, controlled study in Hungary found that translocated European ground squirrels released into plugged artificial burrows had higher recapture rates than those released into unplugged artificial burrows.

BEHAVIOUR (3 STUDIES)

Use (2 studies): Two studies in Australia found that released captive-bred sugar gliders used artificial nest boxes provided.

Behaviour change (1 study): A replicated, before-and-after study in the USA found that translocated Utah prairie dogs released into an area with artificial burrows, after the control of native predators, tended to leave the release site and spent more time being vigilant than before.

Assessment: beneficial (effectiveness 62%; certainty 62%; harms 0%).

<https://www.conservationevidence.com/actions/2453>

Likely to be beneficial

● Release translocated/captive-bred mammals at a specific time (e.g. season, day/night)

Seven studies evaluated the effects of releasing translocated or captive-bred mammals at a specific time (season or day/night). Three studies were in the USA and one each was in the UK, Canada, Ireland and Hungary.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (7 STUDIES)

Survival (7 studies): Four of five studies in the UK, Canada and the USA found that translocated common dormice, black bears and Canadian lynx and captive-bred swift foxes released in a specific season had higher survival rates than those released during another season. The other study found that red squirrels translocated in autumn and winter had similar survival rates. A randomised, replicated, controlled study in Hungary found that translocated European ground squirrels released during the morning had higher recapture rates than those released during the afternoon. A study in the USA found that most translocated kangaroo rats released at dusk in artificial burrows supplied with food died within five days of release.

Condition (1 study): A study in the UK found that common dormice translocated during summer lost less weight than those translocated during spring.

BEHAVIOUR (2 STUDIES)

Behaviour change (2 studies): Two studies in the UK and USA found that common dormice translocated during spring and black bears translocated during winter travelled shorter distances or settled closer to the release site than those translocated during summer.

Assessment: likely to be beneficial (effectiveness 70%; certainty 60%; harms 10%).

<https://www.conservationevidence.com/actions/2447>

● Release translocated/captive-bred mammals in larger unrelated groups

Five studies evaluated the effects of releasing translocated or captive-bred mammals in larger unrelated groups. Two studies were in South Africa, one was in Namibia and South Africa, one was in the USA and one was in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (5 STUDIES)

Reproductive success (3 studies): A replicated, paired sites study in the USA found that black-tailed prairie dogs translocated in larger groups had higher reproductive success than smaller groups. A study in South Africa found that Cape buffalo translocated to a fenced reserve as a larger group formed a single herd and reproduced, whilst a smaller group separated. A study in South Africa found that rehabilitated and captive-bred cheetahs released in groups (unrelated and family) and as individuals reproduced.

Survival (4 studies): A replicated, paired sites study in the USA found that black-tailed prairie dogs translocated in larger groups had higher initial daily survival rate than smaller groups. Two studies (one controlled) in Namibia and South Africa and Australia found that releasing translocated black rhinoceroses and burrowing bettongs in larger groups did not increase survival. A study in South Africa found that most adult rehabilitated and captive-bred cheetahs released in groups (unrelated and family) and as individuals survived at least one year.

BEHAVIOUR (2 STUDIES)

Behaviour change (2 studies): A replicated, paired sites study in the USA found that black-tailed prairie dogs translocated in larger groups attracted more immigrants than smaller groups. A study in South Africa found that Cape buffalo translocated as a larger group formed a single herd and stayed in the fenced reserve, whilst a smaller group scattered and escaped the reserve. *Assessment: likely to be beneficial (effectiveness 67%; certainty 54%; harms 0%).*

<https://www.conservationevidence.com/actions/2462>

● Release translocated/captive-bred mammals to areas outside historical range

Seven studies evaluated the effects of releasing translocated or captive-bred mammals to areas outside their historical range. Three studies were in Australia, one study was in each of Kenya, France and South Africa, and one was a review of studies in Andorra, Spain and France.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (7 STUDIES)

Abundance (5 studies): Three of four studies in Kenya, Australia, France, and South Africa found that after translocating mammals to areas outside their historical range, populations increased for Alpine marmots, most of 22 herbivorous species and bridled nailtail wallabies (including captive and enclosure bred animals). A study in Kenya found that a population of translocated roan persisted for more than six years but did not increase. A review of studies in Andorra, Spain and France found that following translocation to areas outside their native range, alpine marmots had similar densities and family group sizes to those of populations in their native range. Reproductive success (1 study): A study in Kenya found that a population of roan translocated into an area outside their native range persisted and bred for more than six years.

Survival (3 studies): A study in Australia found that captive-bred, translocated and enclosure born bridled nailtail wallabies released into areas outside their historical range had annual survival rates of 40–88% over four years. A study in Australia found that most captive-bred Tasmanian devils released into an area outside their native range survived over four months. A study in Australia found that half the captive-bred and wild-caught translocated eastern barred bandicoots released to a red fox-free island outside their historical range survived for at least two months.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 70%; certainty 52%; harms 15%).

<https://www.conservationevidence.com/actions/2443>

● **Release translocated/captive-bred mammals to islands without invasive predators**

Six studies evaluated the effects of releasing translocated or captive-bred mammals to islands without invasive predators. The six studies were in Australia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (7 STUDIES)

Abundance (2 studies): A study in Australia found that following release of captive-bred dighters on to an island free of introduced predators, numbers increased. A replicated study in Australia found that following release of captive-bred and wild-born brush-tailed bettong onto islands free of foxes or cats, numbers increased on two of four islands.

Reproductive success (3 studies): A study in Australia found that captive-bred proserpine rock-wallabies released on an island without introduced predators established a breeding population. Two studies in Australia found that following release on to islands without invasive predators, captive-bred rufous hare-wallabies and captive-bred dibblers.

Survival (3 studies): A review of 28 translocation studies in Australia found that 67% of marsupial populations translocated to islands without predators survived more than five years, compared to 0% translocated to islands with predators and 20% translocated to the mainland. A study in Australia found that most captive-bred rufous hare-wallabies released on an island without non-native predators survived more than a year. A replicated study in Australia found that wild-born golden bandicoots descended from translocated populations released onto two predator-free islands persisted for 2–3 years.

Condition (1 study): A replicated study in Australia found that wild-born golden bandicoots descended from translocated populations that had been released onto two predator-free islands, maintained genetic diversity relative to founder and source populations.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 80%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2464>

15.13.5 Other

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for other sources of non-native, invasive or other problematic species?	
Likely to be beneficial	<ul style="list-style-type: none"> • Place orphaned or abandoned wild young with captive foster parents • Place orphaned or abandoned wild young with wild foster parents • Provide supplementary water to increase reproduction/survival • Rehabilitate injured, sick or weak mammals
Trade-off between benefit and harms	<ul style="list-style-type: none"> • Hand-rear orphaned or abandoned young in captivity • Provide supplementary food to increase reproduction/survival

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for other sources of non-native, invasive or other problematic species?	
Unknown effectiveness	<ul style="list-style-type: none"> • Cease/reduce payments to cull mammals • Graze herbivores on pasture, instead of sustaining with artificial foods
No evidence found (no assessment)	<ul style="list-style-type: none"> • Temporarily hold females and offspring in fenced area to increase survival of young

Likely to be beneficial

● Place orphaned or abandoned wild young with captive foster parents

Two studies evaluated the effects of placing orphaned or abandoned wild young with captive foster parents. One study was in Canada and one was in the USA.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A controlled study in the USA found that stranded sea otter pups reared in captivity by foster mothers had higher post-release survival than did unfostered pups reared mostly alone, and similar survival to wild pups.

BEHAVIOUR (2 STUDIES)

Behaviour change (2 studies): A study in Canada found that a captive white-tailed deer adopted a wild orphaned fawn. A controlled study in the USA found that stranded sea otter pups reared in captivity by foster mothers began foraging earlier than did unfostered pups reared mostly alone.

Assessment: likely to be beneficial (effectiveness 70%; certainty 40%; harms 7%).

<https://www.conservationevidence.com/actions/2364>

● Place orphaned or abandoned wild young with wild foster parents

Three studies evaluated the effects of placing orphaned or abandoned wild young with wild foster parents. One study was in the USA, one was in South Africa and one was in Botswana.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (3 STUDIES)

Survival (3 studies): Two studies (one controlled) in the USA and Botswana, found that orphaned young black bears and African wild dogs had greater or equal survival compared to animals released alone or young of wild mammals with their biological parents. A study in South Africa found that an orphaned cheetah cub was not accepted by a family of cheetahs.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 52%; certainty 42%; harms 10%).

<https://www.conservationevidence.com/actions/2343>

● Provide supplementary water to increase reproduction/survival

Six studies evaluated the effects on mammals of providing supplementary water to increase reproduction/survival. Two studies were in Australia and one each was in Oman, Portugal, Saudi Arabia and the USA and Mexico.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (5 STUDIES)

Abundance (2 studies): A replicated study in the USA and Mexico found that providing supplementary water was associated with increases in desert bighorn sheep population size. A study in Oman found that a released captive-bred Arabian oryx population initially provided with supplementary water and food increased over 14 years.

Reproduction (2 studies): A study in Saudi Arabia found that released captive-bred Arabian gazelles initially provided with supplementary water and food after release into a fenced area started breeding in the first year. A study in Australia found that most female released captive-reared black-footed rock-wallabies provided with supplementary water after release into a large predator-free fenced area reproduced in the first two years.

Survival (2 studies): A controlled, before-and-after study in Australia found that most released captive-bred hare-wallabies provided with supplementary water, along with supplementary food and predator control, survived at least two months after release into a fenced peninsula. A study in Australia found that over half of released captive-reared black-footed rock-wallabies provided with supplementary water after release into a large predator-free fenced area survived for at least two years.

BEHAVIOUR (1 STUDY)

Use (1 study): A replicated study in Portugal found that artificial waterholes were used by European rabbits and stone martens.

Assessment: likely to be beneficial (effectiveness 80%; certainty 60%; harms 0%).

<https://www.conservationevidence.com/actions/2396>

● **Rehabilitate injured, sick or weak mammals**

Thirteen studies evaluated the effects of rehabilitating injured, sick or weak mammals. Four studies were in the UK, three were in Spain, two were in Argentina and one each was in Uganda, Australia, the USA and Brazil.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (12 STUDIES)

Survival (11 studies): Five studies, in the UK and Spain, found that varying proportions of European hedgehogs released after being rehabilitated in captivity survived during post-release monitoring periods, which ranged from two weeks to 136 days. Five studies, in Australia, Spain, the USA and Brazil, found that four koalas, an Iberian lynx, a gray wolf, a puma and two brown bears released following rehabilitation in captivity survived for varying durations during monitoring periods, which ranged in length from three months to up to seven years. A study in Argentina found that over half of released rehabilitated and captive-reared giant anteaters survived for at least six months.

Condition (2 studies): A study in Uganda found that a snare wound in a white rhinoceros healed after treatment and rehabilitation. A study in the UK found that two of three rehabilitated European hedgehogs lost 12-36% of their body weight after release into the wild.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A controlled study in Argentina found that released wild-born rehabilitated giant anteaters were more nocturnal in their activity patterns than captive-bred individuals.

Assessment: likely to be beneficial (effectiveness 70%; certainty 55%; harms 10%).

<https://www.conservationevidence.com/actions/2352>

Trade-off between benefit and harms

● **Hand-rear orphaned or abandoned young in captivity**

Six studies evaluated the effects of hand-rearing orphaned mammals. Two were in the USA, one each was in Australia, South Africa and India and one was in six countries across North America, Europe and Asia.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (5 STUDIES)

Reproductive success (1 study): One study in India found that three hand-reared orphaned or abandoned greater one-horned rhinoceroses gave birth in the wild.

Survival (5 studies): Five studies (including one controlled and one replicated) in Australia, the USA, India and in six countries across North America, Europe and Asia, found that some hand-reared orphaned or abandoned ringtail possums, white-tailed deer, sea otters, bears and greater one-horned rhinoceroses survived for periods of time after release.

BEHAVIOUR (1 STUDY)

Behaviour change (1 study): A study in South Africa found that a hand-reared, orphaned serval established a home range upon release.

Assessment: trade-off between benefit and harms (effectiveness 50%; certainty 40%; harms 20%).

<https://www.conservationevidence.com/actions/2358>

● Provide supplementary food to increase reproduction/survival

Twenty-four studies evaluated the effects on mammals of providing supplementary food to increase reproduction/survival. Nine studies were in the USA, two were in Canada, two were in South Africa, two were in Poland, and one each was in Sweden, the Netherlands, eSwatini, Spain, Portugal, Slovenia, Austria, Norway and Sweden and one was across North America and Europe.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (18 STUDIES)

Abundance (8 studies): Four of eight studies (including four controlled, two site comparisons and five before-and-after studies) in the USA, Canada, South Africa, Poland and Austria found that supplementary feeding increased the abundance or density of bank voles, red squirrels, striped mice, brown hyena and black-backed jackals. One study found a temporary increase in prairie vole abundance. The other three studies found supplementary feeding not to increase abundance or density of white-footed mice, northern flying squirrels, Douglas squirrels or Eurasian otters.

Reproduction (8 studies): Four of five controlled studies (three also replicated) in the USA, South Africa, Norway and Sweden, Sweden and Spain, found that supplementary food increased the proportion of striped mice that were breeding, the number of arctic fox litters and the size of prairie vole litters. However, there was no increase in the number of arctic fox cubs in each litter or the proportion of female Iberian lynx breeding. One of two replicated studies (one site comparison and one controlled), in the Netherlands and the USA, found that supplementary feeding increased the number of young wild boar

produced and recruited in to the population. The other study found that the number of mule deer produced/adult female did not increase. A review of studies across North America and Europe found that supplementary feeding increased ungulate reproductive rates in five of eight relevant studies.

Survival (9 studies): Four of eight studies (including seven controlled studies and two before-and-after studies) in the USA, Canada, Poland and Spain, found that supplementary feeding increased survival of mule deer, bank voles, northern flying squirrels and eastern cottontail rabbits. Five studies found no increase in survival for white-tailed deer, Douglas squirrels, mule deer, Rocky Mountain bighorn sheep lambs or Iberian lynx. A review of studies across North America and Europe found that supplementary feeding increased ungulate survival in four out of seven relevant studies.

Condition (4 studies): One of three studies (including two controlled and two before-and-after studies) in Poland, the USA, and Canada, found that supplementary food lead to weight gain or weight recovery in bank voles. One study found no body mass increase with supplementary feeding in northern flying squirrels and Douglas squirrels. The third study found mixed results, with supplementary feeding increasing weight gains in some cotton rats, depending on their sex, weight and the time of year. A review of studies from across North America and Europe found that different proportions of studies found supplementary feeding to improve a range of measures of ungulate condition.

BEHAVIOUR (6 STUDIES)

Use (2 studies): A replicated, controlled study in Sweden found that supplementary food increased occupancy of Arctic fox dens. A replicated study in Portugal found that artificial feeding stations were used by European rabbits.

Behaviour (4 studies): Two of three replicated studies (two also controlled), in eSwatini, Slovenia and the USA, found that supplementary feeding led to reduced home range sizes or shorter movements of red deer and elk. The third study found home ranges and movement distances to be similar between fed and unfed multimammate mice. One replicated study in Poland found that supplementary feeding of ungulates altered brown bear behaviour.

Assessment: trade-off between benefit and harms (effectiveness 70%; certainty 70%; harms 20%).

<https://www.conservationevidence.com/actions/2367>

Unknown effectiveness

● Cease/reduce payments to cull mammals

One study evaluated the effects of ceasing or reducing payments to cull mammals. This study was in Sweden and Norway.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A before-and-after study in Sweden and Norway found that fewer brown bears were reported killed after the removal of financial hunting incentives.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 61%; certainty 39%; harms 0%).

<https://www.conservationevidence.com/actions/2349>

● Graze herbivores on pasture, instead of sustaining with artificial foods

One study evaluated the effects of grazing mammalian herbivores on pasture, instead of sustaining with artificial foods. This study was in South Africa.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Reproductive success (1 study): A site comparison study in South Africa found that a population of roan antelope grazed on pasture had a higher population growth rate than populations provided solely with imported feed.

BEHAVIOUR (0 STUDIES)

Assessment: unknown effectiveness (effectiveness 65%; certainty 35%; harms 0%).

<https://www.conservationevidence.com/actions/2398>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Temporarily hold females and offspring in fenced area to increase survival of young.

15.14 Education and awareness raising

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for education and awareness raising?	
Likely to be beneficial	<ul style="list-style-type: none"> • Encourage community-based participation in land management • Provide education programmes to improve behaviour towards mammals and reduce threats • Publish data on ranger performance to motivate increased anti-poacher efforts • Train and support local staff to help reduce persecution of mammals
Unknown effectiveness	<ul style="list-style-type: none"> • Use campaigns and public information to improve behaviour towards mammals and reduce threats
No evidence found (no assessment)	<ul style="list-style-type: none"> • Provide science-based films, radio programmes, or books about mammals to improve behaviour towards mammals and reduce threats

Likely to be beneficial

● Encourage community-based participation in land management

Two studies evaluated the effects of encouraging community-based participation in management of mammals to reduce mammal persecution. One study was in Pakistan and one was in India.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Abundance (1 study): A study in Pakistan found that involving local communities with park management was associated with an increasing population of Himalayan brown bears.

BEHAVIOUR (0 STUDIES)**OTHER (1 STUDY)**

Human behaviour change (1 study): A study in Namibia found that fewer farmers who engaged in community-based management of land, through membership of a conservancy, removed large carnivores from their land than did non-conservancy members.

Assessment: likely to be beneficial (effectiveness 70%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2395>

● **Provide education programmes to improve behaviour towards mammals and reduce threats**

Two studies evaluated the effects of providing education programmes to improve behaviour towards mammals and reduce threats. One study was in South Africa and one was in the USA.

COMMUNITY RESPONSE (0 STUDIES)**POPULATION RESPONSE (1 STUDY)**

Abundance (1 study): A before-and-after study in South Africa found that educating ranchers on ways of reducing livestock losses, along with stricter hunting policies, increased leopard density.

Survival (1 study): A before-and-after study in South Africa found that educating ranchers on ways of reducing livestock losses, along with stricter hunting policies, reduced leopard mortalities.

BEHAVIOUR (0 STUDIES)**OTHER (1 STUDY)**

Human behaviour change (1 study): A replicated, controlled, before-and-after study in the USA found that visiting households to educate about the danger of garbage to black bears did not increase use of wildlife-resistant dumpsters.

Assessment: likely to be beneficial (effectiveness 55%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2423>

● **Publish data on ranger performance to motivate increased anti-poacher efforts**

One study evaluated the effects on poaching incidents of publishing data on ranger performance to motivate increased anti-poacher efforts. This study was in Ghana.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A replicated, before-and-after, site comparison study in Ghana found that when data were publishing on staff performance, poaching incidents decreased on these sites and on sites from which performance data were not published.

BEHAVIOUR (0 STUDIES)

OTHER (1 STUDY)

Human behaviour change (1 study): A replicated, before-and-after, site comparison study in Ghana found that publishing data on staff performance lead to an increase in anti-poaching patrols.

Assessment: likely to be beneficial (effectiveness 60%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2426>

● **Train and support local staff to help reduce persecution of mammals**

One study evaluated the effects of training and supporting local staff to help reduce persecution of mammals. This study was in Kenya.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (1 STUDY)

Survival (1 study): A replicated, before-and-after study in Kenya found that employing local tribesmen to dissuade pastoralists from killing lions and to assist with livestock protection measures, alongside compensating for livestock killed by lions, reduced lion killings by pastoralists.

BEHAVIOUR (0 STUDIES)

Assessment: likely to be beneficial (effectiveness 75%; certainty 40%; harms 0%).

<https://www.conservationevidence.com/actions/2425>

Unknown effectiveness

● **Use campaigns and public information to improve behaviour towards mammals and reduce threats**

Two studies evaluated the effects of using campaigns and public information to improve behaviour towards mammals and reduce threats. One study was in the USA and one was in Lao People's Democratic Republic.

COMMUNITY RESPONSE (0 STUDIES)

POPULATION RESPONSE (0 STUDIES)

BEHAVIOUR (0 STUDIES)

OTHER (2 STUDIES)

Human behaviour change (2 studies): A randomized, replicated, controlled, before-and-after study in the USA found that displaying education signs did not reduce the percentage of garbage containers that were accessible to black bears. A controlled, before-and-after study in Lao People's Democratic Republic found that a social marketing campaign promoting a telephone hotline increased reporting of illegal hunting.

Assessment: unknown effectiveness (effectiveness 40%; certainty 30%; harms 0%).

<https://www.conservationevidence.com/actions/2422>

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Provide science-based films, radio programmes, or books about mammals to improve behaviour towards mammals and reduce threats.

