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What Works in Conservation

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3. BIRD CONSERVATION

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

Assessed: 2015.

Effectiveness measure is the median % score.

Certainty measure is the median % certainty of evidence, 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 was not scored for section 3.11 on invasive species.

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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.

3.1 Habitat protection

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for habitat protection?	
Likely to be beneficial	• Legally protect habitats
Trade-offs between benefit and harms	• Provide or retain un-harvested buffer strips
Unknown effectiveness (limited evidence)	• Ensure connectivity between habitat patches

Likely to be beneficial

Legally protect habitats for birds

Four studies from Europe found that populations increased after habitat protection and a review from China found high use of protected habitats by cranes. A replicated, randomised and controlled study from Argentina found that some, but not all bird groups had higher species richness or were at higher densities in protected habitats. *Assessment: likely to be beneficial (effectiveness 50%; certainty 52%; harms 0%).*

http://www.conservationevidence.com/actions/158

Trade-off between benefit and harms

Provide or retain un-harvested buffer strips

Three replicated studies from the USA found that species richness or abundances were higher in narrow (<100 m) strips of forest, but five replicated studies from North America found that wider strips retained a community more similar to that of uncut forest than narrow strips. Tw replicated studies from the USA found no differences in productivity between wide and narrow buffers, but that predation of artificial nests was higher in buffers than in continuous forest. *Assessment: trade-offs between benefits and harms (effectiveness 60%; certainty 55%; harms 20%).*

http://www.conservationevidence.com/actions/161

Unknown effectiveness (limited evidence)

Ensure connectivity between habitat patches

Two studies of a replicated, controlled experiment in Canadian forests found that some species (not forest specialists) were found at higher densities in forest patches connected to continuous forest, compared to isolated patches and that some species used corridors more than clearcuts between patches. *Assessment: unknown effectiveness — limited evidence (effectiveness 38%; certainty 38%; harms 0%).*

http://www.conservationevidence.com/actions/160

3.2 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	• Raise awareness amongst the general public through campaigns and public information
Unknown effectiveness (limited evidence)	• Provide bird feeding materials to families with young children
No evidence found (no assessment)	• Enhance bird taxonomy skills through higher education and training • Provide training to conservationists and land managers on bird ecology and conservation

Likely to be beneficial

Raise awareness amongst the general public through campaigns and public information

A literature review from North America found that education was not sufficient to change behaviour, but that it was necessary for the success of economic incentives and law enforcement. *Assessment: likely to be beneficial (effectiveness 45%; certainty 48%; harms 0%).*

http://www.conservationevidence.com/actions/162

Unknown effectiveness (limited evidence)

Provide bird feeding materials to families with young children

A single replicated, paired study from the USA found that most children involved in a programme providing families with bird food increased their knowledge of birds, but did not significantly change their environmental attitudes. *Assessment: unknown effectiveness — limited evidence (effectiveness 42%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/163

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Enhance bird taxonomy skills through higher education and training
- Provide training to conservationists and land managers on bird ecology and conservation

3.3 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?	
Unknown effectiveness (limited evidence)	• Angle windows to reduce bird collisions • Mark windows to reduce bird collisions

Unknown effectiveness (limited evidence)

Angle windows to reduce bird collisions

A single randomised, replicated and controlled experiment in the USA found that fewer birds collided with windows angled away from the vertical. *Assessment: unknown effectiveness — limited evidence (effectiveness 60%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/166

Mark windows to reduce bird collisions

Two randomised, replicated and controlled studies found that marking windows did not appear to reduce bird collisions. However, when windows were largely covered with white cloth, or tinted, fewer birds flew towards or collided with them. A third randomised, replicated and controlled study found that fewer birds collided with tinted windows than with un-tinted ones, although the authors noted that the poor reflective quality of the glass could have influenced the results. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/167

3.4 Threat: Agriculture

3.4.1 All farming systems

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for all farming systems?	
Beneficial	• Plant wild bird seed or cover mixture • Provide (or retain) set-aside areas in farmland
Likely to be beneficial	• Create uncultivated margins around intensive arable or pasture fields • Increase the proportion of natural/semi-natural habitat in the farmed landscape • Manage ditches to benefit wildlife • Pay farmers to cover the costs of conservation measures • Plant grass buffer strips/margins around arable or pasture fields • Plant nectar flower mixture/wildflower strips • Leave refuges in fields during harvest • Reduce conflict by deterring birds from taking crops: use bird scarers • Relocate nests at harvest time to reduce nestling mortality • Use mowing techniques to reduce mortality
Unknown effectiveness (limited evidence)	• Control scrub on farmland • Offer per clutch payment for farmland birds • Manage hedges to benefit wildlife • Plant new hedges • Reduce conflict by deterring birds from taking crops: use repellents • Take field corners out of management

Likely to be ineffective or harmful	• Mark bird nests during harvest or mowing
No evidence found (no assessment)	• Cross compliance standards for all subsidy payments • Food labelling schemes relating to biodiversity-friendly farming • Manage stone-faced hedge banks to benefit birds • Plant in-field trees • Protect in-field trees • Reduce field size (or maintain small fields) • Support or maintain low-intensity agricultural systems • Tree pollarding, tree surgery

Beneficial

Plant wild bird seed or cover mixture

Seven of 41 studies found that fields or farms with wild bird cover had higher diversity than other sites, or that wild bird cover held more species than other habitats. Thirty-two studies found that populations, or abundances of some or all species were higher on wild bird cover than other habitats, or that wild bird cover was used more than other habitats. Four of these studies investigated several interventions at once. Thirteen studies found that bird populations or densities were similar on wild bird cover and other habitats that some species were not associated with wild bird cover, or that birds rarely used wild bird cover. Three studies found higher productivities of birds on wild bird cover than other habitats. Two found no differences for some or all species studied. Two studies found that survival of grey partridge or artificial nests increased on wild bird cover; one found lower partridge survival in farms with wild bird cover than other farms. Five studies from the UK found that some wild bird cover crops were used more than others. A study and a review found that the arrangement of wild bird cover in the landscape affected its use by birds. *Assessment: beneficial (effectiveness 81%; certainty 81%; harms 0%).*

http://www.conservationevidence.com/actions/187

Provide (or retain) set-aside areas in farmland

Four out of 23 studies from Europe and North America found more species on set-aside than on crops. One study found fewer. Twenty-one studies found that some species were at higher densities on set-aside than other habitats, or that they used set-aside more often. Four found that some species were found at lower densities on set-aside than other habitats. Three studies found that waders and Eurasian skylarks had higher productivities on set-aside than other crops. One study found that skylarks on set-aside had lower similar or lower productivities than on crops. One study from the UK found that rotational set-aside was used more than non-rotational set-aside, another found no difference. A review from North America and Europe found that naturally regenerated set-aside held more birds and more species than sown set-aside. *Assessment: beneficial (effectiveness 70%; certainty 75%; harms 0%).*

http://www.conservationevidence.com/actions/175

Likely to be beneficial

Create uncultivated margins around intensive arable or pasture fields

One of eight studies found that three sparrow species found on uncultivated margins on a site in the USA were not found on mown field edges. A replicated study from Canada found fewer species in uncultivated margins than in hedges or trees. Three studies found that some bird species were associated with uncultivated margins, or that birds were more abundant on margins than other habitats. One study found that these effects were very weak and four studies of three experiments found that uncultivated margins contained similar numbers of birds as other habitats in winter, or that several species studied did not show associations with margins. A study from the UK found that yellowhammers used uncultivated margins more than crops in early summer. Use fell in uncut margins later in the year. A study from the UK found that grey partridge released on uncultivated margins had high survival. *Assessment: likely to be beneficial (effectiveness 45%; certainty 55%; harms 0%).*

http://www.conservationevidence.com/actions/190

Increase the proportion of natural/semi-natural habitat in the farmed landscape

Two studies from Switzerland and Australia, of the five we captured, found that areas with plantings of native species, or areas under a scheme designed to increase semi-natural habitats (the Swiss Ecological Compensation Areas scheme), held more bird species than other areas. One study from Switzerland found that populations of three bird species increased in areas under the Ecological Compensation Areas scheme. A third Swiss study found that some habitats near Ecological Compensation Areas held more birds than habitats further away, but the overall amount of Ecological Compensation Area had no effect on bird populations. A study from the UK found no effect of habitat-creation on grey partridge populations. *Assessment: likely to be beneficial (effectiveness 45%; certainty 44%; harms 0%).*

http://www.conservationevidence.com/actions/171

Manage ditches to benefit wildlife

One study of four from the UK found that bunded ditches were visited more often by birds than non-bunded ditches. Three studies found that some birds responded positively to ditches managed for wildlife, but that other species did not respond to management, or responded negatively. *Assessment: likely to be beneficial (effectiveness 40%; certainty 49%; harms 14%).*

http://www.conservationevidence.com/actions/180

Pay farmers to cover the costs of conservation measures

Three out of 31 studies found national population increases in three species after payment schemes targeted at their conservation. One found that many other species continued declining. Twenty-two studies found that at least some species were found at higher densities on sites with agri-environment schemes; some differences were present only in summer or only in winter. Fifteen studies found some species at similar densities on agri-environment schemes and non-agri-environment scheme sites or appeared to respond negatively to agri-environment schemes. One study found that grey partridge survival was higher in some years on agri-environment scheme sites. Two studies found higher productivity on agri-environment scheme sites for some species, one found no effect of agri-environment schemes. A review found that some agri-environment schemes options were not being used enough to benefit many species of bird. A study from the UK found that there was no difference in the densities of seed-eating birds in winter between two

agri-environment scheme designations. *Assessment: likely to be beneficial (effectiveness 56%; certainty 80%; harms 0%).*

http://www.conservationevidence.com/actions/172

Plant grass buffer strips/margins around arable or pasture fields

One of 15 studies found more bird species in fields in the USA that were bordered by grass margins than in unbordered fields. Two studies from the UK found no effect of margins on species richness. One study found that more birds used grass strips in fields than used crops. Even more used grass margins. Nine studies from the USA and UK found that sites with grass margins had more positive population trends or higher populations for some birds, or that some species showed strong habitat associations with grass margins. Three studies found no such effect for some or all species. Two studies found that species used margins more than other habitats and one found that birds used cut margins more than uncut during winter, but less than other habitats during summer. A study from the UK found that grey partridge broods were smaller on grass margins than other habitat types. *Assessment: likely to be beneficial (effectiveness 47%; certainty 54%; harms 0%).*

http://www.conservationevidence.com/actions/191

Plant nectar flower mixture/wildflower strips

Three of seven studies found that birds used wildflower strips more than other habitats; two found strips were not used more than other habitats. A study from Switzerland found that Eurasian skylarks were more likely to nest in patches sown with annual weeds than in crops and were less likely to abandon nests. A study from the UK found that management of field margins affected their use more than the seed mix used. *Assessment: likely to be beneficial (effectiveness 55%; certainty 45%; harms 0%).*

http://www.conservationevidence.com/actions/189

Leave refuges in fields during harvest

One study found that fewer gamebirds came into contact with mowing machinery when refuges were left in fields. A study from the UK found that Eurasian skylarks did not nest at higher densities in uncut refuges than in the rest of the field. *Assessment: likely to be beneficial (effectiveness 50%; certainty 41%; harms 0%).*

http://www.conservationevidence.com/actions/193

Reduce conflict by deterring birds from taking crops (using bird scarers)

A controlled paired study in the USA found reduced levels of damage to almond orchards when American crow distress calls were broadcast. A study in Pakistan found that four pest species were less abundant when reflector ribbons were hung above crops compared to where ribbons were not used. *Assessment: likely to be beneficial (effectiveness 66%; certainty 44%; harms 0%).*

http://www.conservationevidence.com/actions/199

Relocate nests at harvest time to reduce nestling mortality

A study from Spain found that Montagu's harrier clutches had higher hatching and fledging rates when they were temporarily moved during harvest than control nests that were not moved. *Assessment: likely to be beneficial (effectiveness 55%; certainty 42%; harms 0%).*

http://www.conservationevidence.com/actions/195

Use mowing techniques to reduce mortality

One of three studies from the UK found a large increase in the national population of corncrakes after a scheme to delay mowing and promote corncrake-friendly mowing techniques. Two studies found lower levels of corncrake and Eurasian skylark mortality when wildlife-friendly mowing techniques were used. *Assessment: likely to be beneficial (effectiveness 85%; certainty 50%; harms 0%).*

http://www.conservationevidence.com/actions/192

Unknown effectiveness (limited evidence)

Control scrub on farmland

A study from the UK found farms with a combined intervention that included scrub control had lower numbers of young grey partridge per adult. *Assessment: unknown effectiveness — limited evidence (effectiveness 7%; certainty 9%; harms 1%).*

http://www.conservationevidence.com/actions/197

Offer per clutch payment for farmland birds

One of two studies from the Netherlands found slightly higher breeding densities of waders on farms with per clutch payment schemes but this and another study found no higher numbers overall. One study found higher hatching success on farms with payment schemes. *Assessment: unknown effectiveness — limited evidence (effectiveness 43%; certainty 35%; harms 0%).*

http://www.conservationevidence.com/actions/196

Manage hedges to benefit wildlife

One of seven studies found no differences in the number of species in a UK site with wildlife-friendly hedge management and sites without. Seven studies found that some species increased in managed hedges or were more likely to be found in them than other habitats. One investigated several interventions at the same time. Four studies found that some species responded negatively or not at all to hedge management or that effects varied across regions of the UK. *Assessment: unknown effectiveness — limited evidence (effectiveness 39%; certainty 38%; harms 3%).*

http://www.conservationevidence.com/actions/177

Plant new hedges

A study from the USA found that populations of northern bobwhites increased following several interventions including the planting of new hedges. *Assessment: unknown effectiveness — limited evidence (effectiveness 23%; certainty 19%; harms 0%).*

http://www.conservationevidence.com/actions/178

Reduce conflict by deterring birds from taking crops (using repellents)

A replicated, randomised and controlled *ex situ* study in the USA found that dickcissels consumed less rice if it was treated with two repellents compared to controls. *Assessment: unknown effectiveness — limited evidence (effectiveness 29%; certainty 27%; harms 0%).*

http://www.conservationevidence.com/actions/200

Take field corners out of management

A study from the UK found that overwinter survival of grey partridge was positively correlated with taking field corners out of management, but this relationship was only significant in one of three winters. There was no relationship with measures of productivity (brood size, young: adult). *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/198

Likely to be ineffective or harmful

Mark bird nests during harvest or mowing

A study from the Netherlands found that fewer northern lapwing nests were destroyed when they were marked with bamboo poles than when they were unmarked. *Assessment: likely to be ineffective or harmful (effectiveness 30%; certainty 45%; harms 20%).*

http://www.conservationevidence.com/actions/148

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Cross compliance standards for all subsidy payments
- Food labelling schemes relating to biodiversity-friendly farming
- Manage stone-faced hedge banks to benefit birds
- Plant in-field trees
- Protect in-field trees
- Reduce field size (or maintain small fields)
- Support or maintain low-intensity agricultural systems
- Tree pollarding, tree surgery

3.4.2 Arable farming

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for arable farming systems?	
Likely to be beneficial	• Create 'skylark plots' • Leave overwinter stubbles • Leave uncropped cultivated margins or fallow land (includes lapwing and stone curlew plots) • Sow crops in spring rather than autumn • Undersow spring cereals, with clover for example
Trade-off between benefit and harms	• Reduce tillage
Unknown effectiveness (limited evidence)	• Implement mosaic management • Increase crop diversity to benefit birds • Plant more than one crop per field (intercropping)
Unlikely to be beneficial	• Create beetle banks
Likely to be ineffective or harmful	• Plant cereals in wide-spaced rows • Revert arable land to permanent grassland
No evidence found (no assessment)	• Add 1% barley into wheat crop for corn buntings • Create corn bunting plots • Leave unharvested cereal headlands within arable fields • Plant nettle strips

Likely to be beneficial

Create 'skylark plots' (undrilled patches in cereal fields)

One study of seven found that the Eurasian skylark population on a farm increased after skylark plots were provided. Another found higher skylark densities on fields with plots in. Two studies from the UK found that skylark

productivity was higher for birds with skylark plots in their territories, a study from Switzerland found no differences. Two studies from Denmark and Switzerland found that skylarks used plots more than expected, but a study from the UK found that seed-eating songbirds did not. *Assessment: likely to be beneficial (effectiveness 65%; certainty 60%; harms 0%).*

http://www.conservationevidence.com/actions/214

Leave overwinter stubbles

Three of fourteen studies report positive population-level changes in two species after winter stubble provision. All investigated several interventions at once. Eight studies found that some farmland birds were found on stubbles or were positively associated with them, three investigated several interventions and one found no more positive associations than expected by chance. A study from the UK found that most species did not preferentially use stubble, compared to cover crops and another found that a greater area of stubble in a site meant lower grey partridge brood size. Five studies from the UK found that management of stubbles influenced their use by birds. One study found that only one species was more common on stubbles under agri-environment schemes. *Assessment: likely to be beneficial (effectiveness 40%; certainty 60%; harms 0%).*

http://www.conservationevidence.com/actions/203

Leave uncropped cultivated margins or fallow land (includes lapwing and stone curlew plots)

Three of nine studies report that the UK population of Eurasian thick-knees increased following a scheme to promote lapwing plots (and other interventions). A study from the UK found that plots did not appear to influence grey partridge populations. Four studies from the UK found that at least one species was associated with lapwing plots, or used them for foraging or nesting. One study found that 11 species were not associated with plots, another that fewer used plots than used crops in two regions of the UK. Two studies found that nesting success was higher on lapwing plots and fallow than in crops. A third found fewer grey partridge chicks per adult on sites with lots of lapwing plots. *Assessment: likely to be beneficial (effectiveness 59%; certainty 55%; harms 15%).*

http://www.conservationevidence.com/actions/213

Sow crops in spring rather than autumn

One study from Sweden, of three examining the effects of spring-sown crops, found that more birds were found on areas with spring, rather than autumn-sown crops. A study from the UK found that several species used the study site for the first time after spring-sowing was started. All three studies found that some populations increased after the start of spring sowing. A study from the UK found that some species declined as well. A study from Sweden found that hatching success of songbirds and northern lapwing was lower on spring-sown, compared with autumn-sown crops. *Assessment: likely to be beneficial (effectiveness 55%; certainty 67%; harms 10%).*

http://www.conservationevidence.com/actions/207

Undersow spring cereals, with clover for example

Four of five studies from the UK found that bird densities were higher on undersown fields or margins than other fields, or that use of fields increased if they were undersown. Two studies of the same experiment found that not all species nested at higher densities in undersown habitats. A study from the UK found that grey partridge populations were lower on sites with large amounts of undersown cereal. *Assessment: likely to be beneficial (effectiveness 60%; certainty 45%; harms 10%).*

http://www.conservationevidence.com/actions/208

Trade-off between benefit and harms

Reduce tillage

Six of ten studies found that some or all bird groups had higher species richness or diversity on reduced-tillage fields, compared to conventional fields in some areas. Two studies found that some groups had lower diversity on reduced-tillage sites, or that there was no difference between treatments. Nine studies found that some species were found at higher densities on reduced tillage fields, six found that some species were at similar or lower densities. Three studies found evidence for higher productivities on reduced-tillage fields. One found that not all measures of productivity were higher. *Assessment: trade-offs between benefits and harms (effectiveness 50%; certainty 48%; harms 51%).*

http://www.conservationevidence.com/actions/211

Unknown effectiveness (limited evidence)

Implement mosaic management

One of two studies from the Netherlands found that northern lapwing population trends, but not those of three other waders, became more positive following the introduction of mosaic management. The other found that black-tailed godwit productivity was higher under mosaic management than other management types. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 33%; harms 0%).*

http://www.conservationevidence.com/actions/130

Increase crop diversity to benefit birds

A study from the UK found that more barnacle geese used a site after the amount of land under cereals was decreased and several other interventions were used. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 19%; harms 0%).*

http://www.conservationevidence.com/actions/201

Plant more than one crop per field (intercropping)

A study from the USA found that 35 species of bird used fields with intercropping, with four nesting, but that productivity from the fields was very low. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 36%; harms 18%).*

http://www.conservationevidence.com/actions/209

Unlikely to be beneficial

Create beetle banks

Two of six studies from the UK found that some bird populations were higher on sites with beetle banks. Both investigated several interventions at once. Two studies found no relationships between bird species abundances or populations and beetle banks. Two studies (including a review) from the UK found that three bird species used beetle banks more than expected, one used them less than expected. *Assessment: unlikely to be beneficial (effectiveness 30%; certainty 41%; harms 0%).*

http://www.conservationevidence.com/actions/217

Likely to be ineffective or harmful

Plant cereals in wide-spaced rows

One of three studies from the UK found that fields with wide-spaced rows held more Eurasian skylark nests than control fields. One study found that fields with wide-spaced rows held fewer nests. Both found that fields with wide-spaced rows held fewer nests than fields with skylark plots. A study from the UK found that skylark chicks in fields with wide-spaced rows had similar diets to those in control fields. *Assessment: likely to be ineffective or harmful (effectiveness 20%; certainty 44%; harms 20%).*

http://www.conservationevidence.com/actions/216

Revert arable land to permanent grassland

All five studies looking at the effects of reverting arable land to grassland found no clear benefit to birds. The studies monitored birds in winter or grey partridges in the UK and wading birds in Denmark. They included three replicated controlled trials. *Assessment: likely to be ineffective or harmful (effectiveness 0%; certainty 64%; harms 10%).*

http://www.conservationevidence.com/actions/210

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Add 1% barley into wheat crop for corn buntings
- Create corn bunting plots
- Leave unharvested cereal headlands within arable fields
- Plant nettle strips

3.4.3 Livestock farming

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for livestock farming systems?	
Likely to be beneficial	• Delay mowing date on grasslands • Leave uncut rye grass in silage fields • Maintain species-rich, semi-natural grassland • Maintain traditional water meadows • Mark fencing to avoid bird mortality • Plant cereals for whole crop silage • Reduce grazing intensity • Reduce management intensity of permanent grasslands
Trade-off between benefit and harms	• Exclude livestock from semi-natural habitat
Unknown effectiveness (limited evidence)	• Create open patches or strips in permanent grassland • Maintain upland heath/moor • Protect nests from livestock to reduce trampling • Provide short grass for waders • Raise mowing height on grasslands
Unlikely to be beneficial	• Use traditional breeds of livestock
No evidence found (no assessment)	• Maintain lowland heathland • Maintain rush pastures • Maintain wood pasture and parkland • Plant Brassica fodder crops • Use mixed stocking

Likely to be beneficial

Delay mowing date on grasslands

Two of five studies (both reviews) found that the UK corncrake populations increased following two schemes to encourage farmers to delay mowing. A

study from the Netherlands found no evidence that waders and other birds were more abundant in fields with delayed mowing. Another study from the Netherlands found that fields with delayed mowing held more birds than other fields, but differences were present before the scheme began and population trends did not differ between treatments. A study from the USA found that fewer nests were destroyed by machinery in late-cut fields, compared with early-cut fields. *Assessment: likely to be beneficial (effectiveness 45%; certainty 52%; harms 0%).*

http://www.conservationevidence.com/actions/223

Leave uncut rye grass in silage fields

All four studies from the UK (including two reviews) found that seed-eating birds were benefited by leaving uncut (or once-cut) rye grass in fields, or that seed-eating species were more abundant on uncut plots. Three studies found that seed-eating birds were more abundant on uncut and ungrazed plots than on uncut and grazed plots. A study from the UK found that the responses of non-seed-eating birds were less certain than seed-eating species, with some species avoiding uncut rye grass. *Assessment: likely to be beneficial (effectiveness 67%; certainty 56%; harms 8%).*

http://www.conservationevidence.com/actions/224

Maintain species-rich, semi-natural grassland

One of two studies found that the populations of five species increased in an area of the UK after the start of management designed to maintain unimproved grasslands. A study from Switzerland found that wetland birds nested at greater densities on managed hay meadows than expected, but birds of open farmland used hay meadows less. *Assessment: likely to be beneficial (effectiveness 41%; certainty 44%; harms 0%).*

http://www.conservationevidence.com/actions/218

Maintain traditional water meadows

One of four studies (from the UK) found that the populations of two waders increased on reserves managed as water meadows. Two studies from the Netherlands found that there were more waders or birds overall on specially managed meadows or 12.5 ha plots, but one found that these differences were present before management began, the other found no differences between individual fields under different management. Two studies from the UK

and Netherlands found that wader populations were no different between specially and conventionally managed meadows, or that wader populations decreased on specially-managed meadows. A study from the UK found that northern lapwing productivity was not high enough to maintain populations on three of four sites managed for waders. *Assessment: likely to be beneficial (effectiveness 50%; certainty 52%; harms 0%).*

http://www.conservationevidence.com/actions/229

Mark fencing to avoid bird mortality

A study from the UK found that fewer birds collided with marked sections of deer fences, compared to unmarked sections. *Assessment: likely to be beneficial (effectiveness 65%; certainty 46%; harms 0%).*

http://www.conservationevidence.com/actions/238

Plant cereals for whole crop silage

Three studies of one experiment found that seed-eating birds used cereal-based wholecrop silage crops more than other crops in summer and winter. Insect-eating species used other crops and grassland more often. *Assessment: likely to be beneficial (effectiveness 55%; certainty 43%; harms 0%).*

http://www.conservationevidence.com/actions/225

Reduce grazing intensity

Nine of eleven studies from the UK and USA found that the populations of some species were higher on fields with reduced grazing intensity, compared to conventionally-grazed fields, or found that birds used these fields more. Three studies investigated several interventions at once. Five studies from Europe found that some or all species were no more numerous, or were less abundant on fields with reduced grazing. A study from the UK found that black grouse populations increased at reduced grazing sites (whilst they declined elsewhere). However, large areas with reduced grazing had low female densities. A study from the USA found that the number of species on plots with reduced grazing increased over time. A study from four European countries found no differences in the number of species on sites with low- or high-intensity grazing. *Assessment: likely to be beneficial (effectiveness 46%; certainty 55%; harms 0%).*

http://www.conservationevidence.com/actions/220

Reduce management intensity of permanent grasslands

Seven of eight European studies found that some or all birds studied were more abundant on grasslands with reduced management intensity, or used them more than other habitats for foraging. Five studies of four experiments found that some or all species were found at lower or similar abundances on reduced-management grasslands, compared to intensively-managed grasslands. *Assessment: likely to be beneficial (effectiveness 65%; certainty 46%; harms 0%).*

http://www.conservationevidence.com/actions/219

Trade-off between benefit and harms

Exclude livestock from semi-natural habitat

Two studies from the USA, out of 11 overall, found higher species richness on sites with grazers excluded. A study from Argentina found lower species richness and one from the USA found no difference. Seven studies from the USA found that overall bird abundance, or the abundances of some species were higher in sites with grazers excluded. Seven studies from the USA and Argentina found that overall abundance or the abundance of some species were lower on sites without grazers, or did not differ. Three studies found that productivities were higher on sites with grazers excluded. In one, the difference was only found consistently in comparison with improved pastures, not unimproved. *Assessment: trade-offs between benefits and harms (effectiveness 50%; certainty 57%; harms 30%).*

http://www.conservationevidence.com/actions/236

Unknown effectiveness (limited evidence)

Create open patches or strips in permanent grassland

A study from the UK found that Eurasian skylarks used fields with open strips in, but that variations in skylark numbers were too great to draw conclusions from this finding. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 19%; harms 0%).*

http://www.conservationevidence.com/actions/239

Maintain upland heath/moor

A study from the UK found that bird populations in one region were increasing with agri-environment guidelines on moor management. There

were some problems with overgrazing, burning and scrub encroachment. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/230

Protect nests from livestock to reduce trampling

One of two studies found that a population of Chatham Island oystercatchers increased following several interventions including the erection of fencing around individual nests. A study from Sweden found that no southern dunlin nests were trampled when protected by cages; some unprotected nests were destroyed. *Assessment: unknown effectiveness — limited evidence (effectiveness 56%; certainty 19%; harms 0%).*

http://www.conservationevidence.com/actions/237

Provide short grass for waders

A study from the UK found that common starlings and northern lapwing spent more time foraging on areas with short swards, compared to longer swards. *Assessment: unknown effectiveness — limited evidence (effectiveness 41%; certainty 32%; harms 0%).*

http://www.conservationevidence.com/actions/221

Raise mowing height on grasslands

One of two studies from the UK found that no more foraging birds were attracted to plots with raised mowing heights, compared to plots with shorter grass. A review from the UK found that Eurasian skylarks had higher productivity on sites with raised mowing heights, but this increase was not enough to maintain local populations. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 36%; harms 0%).*

http://www.conservationevidence.com/actions/222

Unlikely to be beneficial

Use traditional breeds of livestock

A study from four countries in Europe found no differences in bird abundances in areas grazed with traditional or commercial breeds. *Assessment: unlikely to be beneficial (effectiveness 0%; certainty 44%; harms 0%).*

http://www.conservationevidence.com/actions/233

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Maintain lowland heathland
- Maintain rush pastures
- Maintain wood pasture and parkland
- Plant Brassica fodder crops
- Use mixed stocking

3.4.4 Perennial, non-timber crops

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for perennial, non-timber crops?	
Unknown effectiveness (limited evidence)	• Maintain traditional orchards
No evidence found (no assessment)	• Manage perennial bioenergy crops to benefit wildlife

Unknown effectiveness (limited evidence)

Maintain traditional orchards

Two site comparison studies from the UK and Switzerland found that traditional orchards offer little benefit to birds. In Switzerland only one breeding bird species was associated with traditional orchards. In the UK, the population density of cirl bunting was negatively related to the presence of orchards. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 24%; harms 0%).*

http://www.conservationevidence.com/actions/240

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Manage perennial bioenergy crops to benefit wildlife

3.4.5 Aquaculture

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for aquaculture?	
Likely to be beneficial	• Deter birds from landing on shellfish culture gear • Disturb birds at roosts • Provide refuges for fish within ponds • Use electric fencing to exclude fish-eating birds • Use 'mussel socks' to prevent birds from attacking shellfish • Use netting to exclude fish-eating birds
Unknown effectiveness (limited evidence)	• Increase water turbidity to reduce fish predation by birds • Translocate birds away from fish farms • Use in-water devices to reduce fish loss from ponds
Unlikely to be beneficial	• Disturb birds using foot patrols • Spray water to deter birds from ponds
Likely to be ineffective or harmful	• Scare birds from fish farms

Likely to be beneficial

Deter birds from landing on shellfish culture gear

A study from Canada found that fewer birds landed on oyster cages fitted with spikes than control cages. The same study found that fewer birds landed on oyster bags suspended 6 cm, but not 3 cm, underwater, compared to bags on the surface. *Assessment for using spikes on oyster cages: likely to be beneficial (effectiveness 60%; certainty 43%; harms 0%). Assessment for suspending oyster bags under water: likely to be beneficial (effectiveness 55%; certainty 43%; harms 0%).*

http://www.conservationevidence.com/actions/257
http://www.conservationevidence.com/actions/256

Disturb birds at roosts

One study from the USA found reduced fish predation after fish-eating birds were disturbed at roosts. Five studies from the USA and Israel found that birds foraged less near disturbed roosts, or left the area after being disturbed. One found the effects were only temporary. *Assessment: likely to be beneficial (effectiveness 67%; certainty 45%; harms 0%).*

http://www.conservationevidence.com/actions/245

Provide refuges for fish within ponds

A study from the UK found that cormorants caught fewer fish in a pond with fish refuges in, compared to a control pond. *Assessment: likely to be beneficial (effectiveness 65%; certainty 43%; harms 0%).*

http://www.conservationevidence.com/actions/253

Use electric fencing to exclude fish-eating birds

Two before-and-after trials from the USA found lower use of fish ponds by herons after electric fencing was installed. *Assessment: likely to be beneficial (effectiveness 60%; certainty 49%; harms 0%).*

http://www.conservationevidence.com/actions/247

Use 'mussel socks' to prevent birds from attacking shellfish

A study from Canada found that mussel socks with protective sleeves lost fewer medium-sized mussels (but not small or large mussels), compared to unprotected mussel socks. *Assessment: likely to be beneficial (effectiveness 50%; certainty 41%; harms 0%).*

http://www.conservationevidence.com/actions/250

Use netting to exclude fish-eating birds

Two studies from Germany and the USA, and a review, found that netting over ponds reduced the loss of fish to predatory birds. Two studies from the USA and the Netherlands found that birds still landed on ponds with netting, but that they altered their behaviour, compared to open ponds. Two studies from Germany and Israel found that some birds became entangled in netting over ponds. *Assessment: likely to be beneficial (effectiveness 60%; certainty 59%; harms 15%).*

http://www.conservationevidence.com/actions/248

Unknown effectiveness (limited evidence)

Increase water turbidity to reduce fish predation by birds

An *ex situ* study from France found that egret foraging efficiency was reduced in more turbid water. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 23%; harms 0%).*

http://www.conservationevidence.com/actions/252

Translocate birds away from fish farms

A study from the USA found that translocating birds appeared to reduce bird numbers at a fish farm. A study from Belgium found that it did not. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 33%; harms 0%).*

http://www.conservationevidence.com/actions/251

Use in-water devices to reduce fish loss from ponds

A study from the USA found that fewer cormorants used two ponds after underwater ropes were installed; a study from Australia found that no fewer cormorants used ponds with gill nets in. *Assessment: unknown effectiveness — limited evidence (effectiveness 34%; certainty 35%; harms 0%).*

http://www.conservationevidence.com/actions/254

Unlikely to be beneficial

Disturb birds using foot patrols

Two replicated studies from Belgium and Australia found that using foot patrols to disturb birds from fish farms did not reduce the number of birds present or fish consumption. *Assessment: unlikely to be beneficial (effectiveness 0%; certainty 45%; harms 0%).*

http://www.conservationevidence.com/actions/249

Spray water to deter birds from ponds

A study from Sweden found that spraying water deterred birds from fish ponds, but that some birds became habituated to the spray. *Assessment: unlikely to be beneficial (effectiveness 31%; certainty 43%; harms 0%).*

http://www.conservationevidence.com/actions/255

Likely to be ineffective or harmful

Scare birds from fish farms

One study from Israel found a population increase in fish-eating birds after efforts to scare them from fish farms, possibly due to lower persecution. One of two studies found evidence for reduced loss of fish when birds were scared from farms. Two studies from Australia and Belgium found that disturbing birds using foot patrols was not effective. Ten of 11 studies from across the world found some effects for acoustic deterrents, five of seven found that visual deterrents were effective. In both cases some studies found that results were temporary, birds became habituated or that some deterrents were effective, whilst others were not. One study found that trained raptors were effective, one found little evidence for the effectiveness of helicopters or light aircraft. *Assessment: likely to be ineffective or harmful (effectiveness 36%; certainty 64%; harms 0%).*

http://www.conservationevidence.com/actions/244

3.5 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?	
Unknown effectiveness (limited evidence)	• Paint wind turbines to increase their visibility

Unknown effectiveness (limited evidence)

Paint wind turbines to increase their visibility

A single, controlled *ex situ* experiment found that thick black stripes running across a wind turbine's blades made them more conspicuous to an American kestrel *Falco sparverius* than control (unpatterned) blades. Other designs were less visible or indistinguishable from controls. *Assessment: unknown effectiveness — limited evidence (effectiveness 16%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/258

3.6 Threat: Transportation and service corridors

3.6.1 Verges and airports

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for verges and airports?	
Likely to be beneficial	• Scare or otherwise deter birds from airports
Unknown effectiveness (limited evidence)	• Mow roadside verges
No evidence found (no assessment)	• Sow roadside verges

Likely to be beneficial

Scare or otherwise deter birds from airports

Two replicated studies in the UK and USA found that fewer birds used areas of long grass at airports, but no data were provided on the effect of long grass on strike rates or bird mortality. *Assessment: likely to be beneficial (effectiveness 50%; certainty 44%; harms 0%).*

http://www.conservationevidence.com/actions/261

Unknown effectiveness (limited evidence)

Mow roadside verges

A single replicated, controlled trial in the USA found that mowed roadside verges were less attractive to ducks as nesting sites, but had higher nesting success after four years. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 30%; harms 9%).*

http://www.conservationevidence.com/actions/259

No evidence found (no assessment)

We have captured no evidence for the following intervention:

- Sow roadside verges

3.6.2 Power lines and electricity pylons

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for power lines and electricity pylons?	
Beneficial	• Mark power lines
Likely to be beneficial	• Bury or isolate power lines • Insulate electricity pylons • Remove earth wires from power lines • Use perch-deterrents to stop raptors perching on pylons
Unknown effectiveness (limited evidence)	• Thicken earth wires
Unlikely to be beneficial	• Add perches to electricity pylons • Reduce electrocutions by using plastic, not metal, leg rings to mark birds • Use raptor models to deter birds from power lines

Beneficial

Mark power lines

A total of eight studies and two literature reviews from across the world found that marking power lines led to significant reductions in bird collision mortalities. Different markers had different impacts. *Assessment: beneficial (effectiveness 81%; certainty 85%; harms 0%).*

http://www.conservationevidence.com/actions/265

Likely to be beneficial

Bury or isolate power lines

A single before-and-after study in Spain found a dramatic increase in juvenile eagle survival following the burial or isolation of dangerous power lines. *Assessment: likely to be beneficial (effectiveness 60%; certainty 44%; harms 0%).*

http://www.conservationevidence.com/actions/262

Insulate electricity pylons

A single before-and-after study in the USA found that insulating power pylons significantly reduced the number of Harris's hawks electrocuted. *Assessment: likely to be beneficial (effectiveness 60%; certainty 45%; harms 0%).*

http://www.conservationevidence.com/actions/268

Remove earth wires from power lines

Two before-and-after studies from Norway and the USA describe significant reductions in bird collision mortalities after earth wires were removed from sections of power lines. *Assessment: likely to be beneficial (effectiveness 90%; certainty 60%; harms 0%).*

http://www.conservationevidence.com/actions/263

Use perch-deterrents to stop raptors perching on pylons

A single controlled study in the USA found that significantly fewer raptors were found near perch-deterrent lines, compared to controls, but no information on electrocutions was provided. *Assessment: likely to be beneficial (effectiveness 50%; certainty 45%; harms 0%).*

http://www.conservationevidence.com/actions/269

Unknown effectiveness (limited evidence)

Thicken earth wires

A single paired sites trial in the USA found no reduction in crane species collision rates in a wire span with an earth wire three times thicker than normal. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 25%; harms 0%).*

http://www.conservationevidence.com/actions/264

Unlikely to be beneficial

Add perches to electricity pylons

A single before-and-after study in Spain found that adding perches to electricity pylons did not reduce electrocutions of Spanish imperial eagles. *Assessment: unlikely to be beneficial (effectiveness 0%; certainty 42%; harms 0%).*

http://www.conservationevidence.com/actions/267

Reduce electrocutions by using plastic, not metal, leg rings to mark birds

A single replicated and controlled study in the USA found no evidence that using plastic leg rings resulted in fewer raptors being electrocuted. *Assessment: unlikely to be beneficial (effectiveness 0%; certainty 42%; harms 0%).*

http://www.conservationevidence.com/actions/270

Use raptor models to deter birds from power lines

A single paired sites trial in Spain found that installing raptor models near power lines had no impact on bird collision mortalities. *Assessment: unlikely to be beneficial (effectiveness 0%; certainty 43%; harms 0%)*

http://www.conservationevidence.com/actions/266

3.7 Threat: Biological resource use

3.7.1 Reducing exploitation and conflict

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reducing exploitation and conflict?	
Beneficial	• Use legislative regulation to protect wild populations
Likely to be beneficial	• Use wildlife refuges to reduce hunting disturbance
Unknown effectiveness (limited evidence)	• Employ local people as 'biomonitors' • Increase 'on-the-ground' protection to reduce unsustainable levels of exploitation • Introduce voluntary 'maximum shoot distances' • Mark eggs to reduce their appeal to collectors • Move fish-eating birds to reduce conflict with fishermen • Promote sustainable alternative livelihoods • Provide 'sacrificial grasslands' to reduce conflict with farmers • Relocate nestlings to reduce poaching • Use education programmes and local engagement to help reduce persecution or exploitation of species
No evidence found (no assessment)	• Use alerts during shoots to reduce mortality of non-target species

Scare fish-eating birds from areas to reduce conflict

Studies investigating scaring fish from fishing areas are discussed in 'Threat: Agriculture — Aquaculture'.

Beneficial

Use legislative regulation to protect wild populations

Five out of six studies from Europe, Asia, North America and across the world, found evidence that stricter legislative protection was correlated with increased survival, lower harvests or increased populations. The sixth, a before-and-after study from Australia, found that legislative protection did not reduce harvest rates. *Assessment: beneficial (effectiveness 65%; certainty 65%; harms 0%).*

http://www.conservationevidence.com/actions/271

Likely to be beneficial

Use wildlife refuges to reduce hunting disturbance

Three studies from the USA and Europe found that more birds used refuges where hunting was not allowed, compared to areas with hunting, and more used the refuges during the open season. However, no studies examined the population-level effects of refuges. *Assessment: likely to be beneficial (effectiveness 45%; certainty 45%; harms 0%).*

http://www.conservationevidence.com/actions/278

Unknown effectiveness (limited evidence)

Employ local people as 'biomonitors'

A single replicated study in Venezuela found that poaching of parrot nestlings was significantly lower in years following the employment of five local people as 'biomonitors'. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 19%; harms 0%).*

http://www.conservationevidence.com/actions/275

Increase 'on-the-ground' protection to reduce unsustainable levels of exploitation

Two before-and-after studies from Europe and Central America found increases in bird populations and recruitment following stricter anti-poaching methods or the stationing of a warden on the island in question. However, the increases in Central America were only short-term, and were lost when

the intensive effort was reduced. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 25%; harms 0%).*

http://www.conservationevidence.com/actions/272

Introduce voluntary 'maximum shoot distances'

A single study from Denmark found a significant reduction in the injury rates of pink-footed geese following the implementation of a voluntary maximum shooting distance. *Assessment: unknown effectiveness — limited evidence (effectiveness 40%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/279

Mark eggs to reduce their appeal to collectors

A single before-and-after study in Australia found increased fledging success of raptor eggs in a year they were marked with a permanent pen. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 35%; harms 0%).*

http://www.conservationevidence.com/actions/276

Move fish-eating birds to reduce conflict with fishermen

A single before-and-after study in the USA found that Caspian tern chicks had a lower proportion of commercial fish in their diet following the movement of the colony away from an important fishery. *Assessment: unknown effectiveness — limited evidence (effectiveness 32%; certainty 24%; harms 0%).*

http://www.conservationevidence.com/actions/281

Promote sustainable alternative livelihoods

A single before-and-after study in Costa Rica found that a scarlet macaw population increased following several interventions including the promotion of sustainable, macaw-based livelihoods. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 19%; harms 0%).*

http://www.conservationevidence.com/actions/273

Provide 'sacrificial grasslands' to reduce conflict with farmers

Two UK studies found that more geese used areas of grassland managed for them, but that this did not appear to attract geese from outside the study site

and therefore was unlikely to reduce conflict with farmers. *Assessment: unknown effectiveness — limited evidence (effectiveness 18%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/280

Relocate nestlings to reduce poaching

A single replicated study in Venezuela found a significant reduction in poaching rates and an increase in fledging rates of yellow-shouldered amazons when nestlings were moved into police premises overnight. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 30%; harms 0%).*

http://www.conservationevidence.com/actions/277

Use education programmes and local engagement to help reduce persecution or exploitation of species

Six out of seven studies from across the world found increases in bird populations or decreases in mortality following education programmes, whilst one study from Venezuela found no evidence that poaching decreased following an educational programme. In all but one study reporting successes, other interventions were also used, and a literature review from the USA and Canada argues that education was not sufficient to change behaviour, although a Canadian study found that there was a significant shift in local peoples' attitudes to conservation and exploited species following educational programmes. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 30%; harms 0%).*

http://www.conservationevidence.com/actions/274

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Use alerts during shoots to reduce mortality of non-target species

3.7.2 Reducing fisheries bycatch

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reducing fisheries bycatch?	
Beneficial	• Use streamer lines to reduce seabird bycatch on longlines
Likely to be beneficial	• Mark trawler warp cables to reduce seabird collisions • Reduce seabird bycatch by releasing offal overboard when setting longlines • Weight baits or lines to reduce longline bycatch of seabirds
Trade-off between benefit and harms	• Set lines underwater to reduce seabird bycatch • Set longlines at night to reduce seabird bycatch
Unknown effectiveness (limited evidence)	• Dye baits to reduce seabird bycatch • Thaw bait before setting lines to reduce seabird bycatch • Turn deck lights off during night-time setting of longlines to reduce bycatch • Use a sonic scarer when setting longlines to reduce seabird bycatch • Use acoustic alerts on gillnets to reduce seabird bycatch • Use bait throwers to reduce seabird bycatch • Use bird exclusion devices such as 'Brickle curtains' to reduce seabird mortality when hauling longlines • Use high visibility mesh on gillnets to reduce seabird bycatch • Use shark liver oil to deter birds when setting lines
Likely to be ineffective or harmful	• Use a line shooter to reduce seabird bycatch
No evidence found (no assessment)	• Reduce bycatch through seasonal or area closures • Reduce 'ghost fishing' by lost/discarded gear • Reduce gillnet deployment time to reduce seabird bycatch • Set longlines at the side of the boat to reduce seabird bycatch

	• Tow buoys behind longlining boats to reduce seabird bycatch • Use a water cannon when setting longlines to reduce seabird bycatch • Use high-visibility longlines to reduce seabird bycatch • Use larger hooks to reduce seabird bycatch on longlines

Beneficial

Use streamer lines to reduce seabird bycatch on longlines

Ten studies from coastal and pelagic fisheries across the globe found strong evidence for reductions in bycatch when streamer lines were used. Five studies from the South Atlantic, New Zealand and Australia were inconclusive, uncontrolled or had weak evidence for reductions. One study from the sub-Antarctic Indian Ocean found no evidence for reductions. Three studies from around the world found that bycatch rates were lower when two streamers were used compared to one, and one study found rates were lower still with three streamers. *Assessment: beneficial (effectiveness 65%; certainty 75%; harms 0%).*

http://www.conservationevidence.com/actions/285

Likely to be beneficial

Mark trawler warp cables to reduce seabird collisions

A single replicated and controlled study in Argentina found lower seabird mortality (from colliding with warp cables) when warp cables were marked with orange traffic cones. *Assessment: likely to be beneficial (effectiveness 54%; certainty 40%; harms 0%).*

http://www.conservationevidence.com/actions/305

Reduce seabird bycatch by releasing offal overboard when setting longlines

Two replicated and controlled studies in the South Atlantic and sub-Antarctic Indian Ocean found significantly lower seabird bycatch rates when offal was

released overboard as lines were being set. *Assessment: likely to be beneficial (effectiveness 51%; certainty 50%; harms 0%).*

http://www.conservationevidence.com/actions/299

Weight baits or lines to reduce longline bycatch of seabirds

Three replicated and controlled studies from the Pacific found lower bycatch rates of some seabird species on weighted longlines. An uncontrolled study found low bycatch rates with weighted lines but that weights only increased sink rates in small sections of the line. Some species were found to attack weighted lines more than control lines. *Assessment: likely to be beneficial (effectiveness 46%; certainty 45%; harms 15%).*

http://www.conservationevidence.com/actions/296

Trade-off between benefit and harms

Set lines underwater to reduce seabird bycatch

Five studies in Norway, South Africa and the North Pacific found lower seabird bycatch rates on longlines set underwater. However, results were species-specific, with shearwaters and possibly albatrosses continuing to take baits set underwater. *Assessment: trade-offs between benefits and harms (effectiveness 61%; certainty 50%; harms 24%).*

http://www.conservationevidence.com/actions/288

Set longlines at night to reduce seabird bycatch

Six out of eight studies from around the world found lower bycatch rates when longlines were set at night, but the remaining two found higher bycatch rates (of northern fulmar in the North Pacific and white-chinned petrels in the South Atlantic, respectively). Knowing whether bycatch species are night- or day-feeding is therefore important in reducing bycatch rates. *Assessment: trade-offs between benefits and harms (effectiveness 60%; certainty 70%; harms 48%).*

http://www.conservationevidence.com/actions/283

Unknown effectiveness (limited evidence)

Dye baits to reduce seabird bycatch

A single randomised, replicated and controlled trial in Hawaii, USA, found that albatrosses attacked baits at significantly lower rates when baits were

dyed blue. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/293

Thaw bait before setting lines to reduce seabird bycatch

A study from Australia found that longlines set using thawed baits caught significantly fewer seabirds than controls. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 30%; harms 0%).*

http://www.conservationevidence.com/actions/298

Turn deck lights off during night-time setting of longlines to reduce bycatch

A single replicated and controlled study in the South Atlantic found lower seabird bycatch rates on night-set longlines when deck lights were turned off. *Assessment: unknown effectiveness — limited evidence (effectiveness 51%; certainty 21%; harms 0%).*

http://www.conservationevidence.com/actions/284

Use a sonic scarer when setting longlines to reduce seabird bycatch

A single study from the South Atlantic found that seabirds only temporarily changed behaviour when a sonic scarer was used, and seabird bycatch rates did not appear to be lower on lines set with a scarer. *Assessment: unknown effectiveness — limited evidence (effectiveness 2%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/295

Use acoustic alerts on gillnets to reduce seabird bycatch

A randomised, replicated and controlled trial in a coastal fishery in the USA found that fewer guillemots (common murres) but not rhinoceros auklets were caught in gillnets fitted with sonic alerts. *Assessment: unknown effectiveness — limited evidence (effectiveness 44%; certainty 21%; harms 0%).*

http://www.conservationevidence.com/actions/301

Use bait throwers to reduce seabird bycatch

A single analysis found significantly lower seabird bycatch on Australian longliners when a bait thrower was used to set lines. *Assessment: unknown effectiveness — limited evidence (effectiveness 46%; certainty 30%; harms 0%).*

http://www.conservationevidence.com/actions/291

Use bird exclusion devices such as 'Brickle curtains' to reduce seabird mortality when hauling longlines

A single replicated study found that Brickle curtains reduced the number of seabirds caught, when compared to an exclusion device using only a single boom. Using purse seine buoys as well as the curtain appeared to be even more effective, but sample sizes did not allow useful comparisons. *Assessment: unknown effectiveness — limited evidence (effectiveness 48%; certainty 30%; harms 0%).*

http://www.conservationevidence.com/actions/302

Use high visibility mesh on gillnets to reduce seabird bycatch

A single randomised, replicated and controlled trial in a coastal fishery in the USA found that fewer guillemots (common murres) and rhinoceros auklets were caught in gillnets with higher percentages of brightly coloured netting. However, such netting also reduced the catch of the target salmon. *Assessment: unknown effectiveness — limited evidence (effectiveness 60%; certainty 30%; harms 0%).*

http://www.conservationevidence.com/actions/303

Use shark liver oil to deter birds when setting lines

Two out of three replicated and controlled trials in New Zealand found that fewer birds followed boats or dived for baits when non-commercial shark oil was dripped off the back of the boat. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 25%; harms 0%).*

http://www.conservationevidence.com/actions/297

Likely to be ineffective or harmful

Use a line shooter to reduce seabird bycatch

Two randomised, replicated and controlled trials found that seabird bycatch rates were higher (in the North Pacific) or the same (in Norway) on longlines set using line shooters, compared to those set without a shooter. *Assessment: likely to be ineffective or harmful (effectiveness 0%; certainty 50%; harms 40%).*

http://www.conservationevidence.com/actions/290

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Reduce bycatch through seasonal or area closures
- Reduce 'ghost fishing' by lost/discarded gear
- Reduce gillnet deployment time to reduce seabird bycatch
- Set longlines at the side of the boat to reduce seabird bycatch
- Tow buoys behind longlining boats to reduce seabird bycatch
- Use a water cannon when setting longlines to reduce seabird bycatch
- Use high-visibility longlines to reduce seabird bycatch
- Use larger hooks to reduce seabird bycatch on longlines

3.8 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?	
Likely to be beneficial	• Provide paths to limit disturbance • Start educational programmes for personal watercraft owners • Use signs and access restrictions to reduce disturbance at nest sites • Use voluntary agreements with local people to reduce disturbance
Unknown effectiveness (limited evidence)	• Habituate birds to human visitors • Use nest covers to reduce the impact of research on predation of ground-nesting seabirds
No evidence found (no assessment)	• Reduce visitor group sizes • Set minimum distances for approaching birds (buffer zones)

Likely to be beneficial

Provide paths to limit disturbance

A study from the UK found that two waders nested closer to a path, or at higher densities near the path, following resurfacing, which resulted in far fewer people leaving the path. *Assessment: likely to be beneficial (effectiveness 50%; certainty 40%; harms 0%).*

http://www.conservationevidence.com/actions/311

Start educational programmes for personal watercraft owners

A before-and-after study in the USA found that common tern reproduction increased, and rates of disturbance decreased, following a series of educational programmes aimed at recreational boat users. *Assessment: likely to be beneficial (effectiveness 40%; certainty 40%; harms 0%).*

http://www.conservationevidence.com/actions/314

Use signs and access restrictions to reduce disturbance at nest sites

Six studies from across the world found increased numbers of breeders, higher reproductive success or lower levels of disturbance in waders and terns following the start of access restrictions or the erection of signs near nesting areas. Two studies from Europe and Antarctica found no effect of access restrictions on reproductive success in eagles and penguins, respectively. *Assessment: likely to be beneficial (effectiveness 59%; certainty 55%; harms 10%).*

http://www.conservationevidence.com/actions/309

Use voluntary agreements with local people to reduce disturbance

A before-and-after trial in the USA found significantly lower rates of waterfowl disturbance following the establishment of a voluntary waterfowl avoidance area, despite an overall increase in boat traffic. *Assessment: likely to be beneficial (effectiveness 50%; certainty 40%; harms 0%).*

http://www.conservationevidence.com/actions/313

Unknown effectiveness (limited evidence)

Habituate birds to human visitors

A study from Australia found that bridled terns from heavily disturbed sites had similar or higher reproductive success compared with less-disturbed sites, possibly suggesting that habituation had occurred. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/315

Use nest covers to reduce the impact of research on predation of ground-nesting seabirds

A before-and-after study from Canada found that hatching success of Caspian terns was significantly higher when researchers protected nests after disturbing adults from them. *Assessment: unknown effectiveness — limited evidence (effectiveness 41%; certainty 35%; harms 19%).*

http://www.conservationevidence.com/actions/316

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Reduce visitor group sizes
- Set minimum distances for approaching birds (buffer zones)

3.9 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	• Create scrapes and pools in wetlands and wet grasslands • Provide deadwood/snags in forests: use ring-barking, cutting or silvicides • Use patch retention harvesting instead of clearcutting
Trade-off between benefit and harms	• Clear or open patches in forests • Employ grazing in artificial grassland/pastures • Employ grazing in natural grasslands • Employ grazing in non-grassland habitats • Manage water level in wetlands • Manually control or remove midstorey and ground-level vegetation (including mowing, chaining, cutting etc) in forests • Mow or cut natural grasslands • Mow or cut semi-natural grasslands/pastures • Manually control or remove midstorey and ground-level vegetation (including mowing, chaining, cutting etc) in shrubland • Raise water levels in ditches or grassland • Thin trees within forests

	• Use prescribed burning: grasslands • Use prescribed burning: pine forests • Use prescribed burning: savannahs • Use prescribed burning: shrublands • Use selective harvesting/logging instead of clearcutting
Unknown effectiveness (limited evidence)	• Clearcut and re-seed forests • Coppice trees • Fertilise grasslands • Manage woodland edges for birds • Manually control or remove midstorey and ground-level vegetation: reedbeds • Manually control or remove midstorey and ground-level vegetation: savannahs • Plant trees to act as windbreaks • Plough habitats • Provide deadwood/snags in forests: add woody debris to forests • Remove coarse woody debris from forests • Replace non-native species of tree/shrub • Re-seed grasslands • Use environmentally sensitive flood management • Use fire suppression/control • Use greentree reservoir management • Use prescribed burning: Australian sclerophyll forest • Use shelterwood cutting instead of clearcutting • Use variable retention management during forestry operations
Likely to be ineffective or harmful	• Apply herbicide to mid- and understorey vegetation • Treat wetlands with herbicides • Use prescribed burning: coastal habitats • Use prescribed burning: deciduous forests
No evidence found (no assessment)	• Protect nest trees before burning

Likely to be beneficial

Create scrapes and pools in wetlands and wet grasslands

Four out of six studies from the UK and North America found that more bird used sites, or breeding populations on sites increased, after ponds or scrapes were created. A study from the USA found that some duck species used newly created ponds and others used older ponds. A study from the UK found that northern lapwing chicks foraged in newly created features and that chick condition was higher in sites with a large number of footdrains. *Assessment: likely to be beneficial (effectiveness 75%; certainty 60%; harms 0%).*

http://www.conservationevidence.com/actions/359

Provide deadwood/snags in forests (use ring-barking, cutting or silvicides)

One of five studies found that forest plots provided with snags had higher bird diversity and abundance than plots without snags. Three of four studies from the USA and UK found that species used artificially-created snags for nesting and foraging. One study from the USA found that use increased with how long a snag had been dead. *Assessment: likely to be beneficial (effectiveness 45%; certainty 50%; harms 0%).*

http://www.conservationevidence.com/actions/343

Use patch retention harvesting instead of clearcutting

One of two studies (from the USA) found that areas under patch retention harvesting contained more birds of more species than clearcut areas, retaining similar numbers to unharvested areas. Two studies found that forest specialist species were found more frequently in patch retention plots than under other management. Habitat generalists declined on patch retention sites compared to other managements. *Assessment: likely to be beneficial (effectiveness 70%; certainty 46%; harms 0%).*

http://www.conservationevidence.com/actions/330

Trade-off between benefit and harms

Clear or open patches in forests

Seven out of nine studies from the UK and USA found that early-successional species increased in clearcut areas of forests, compared to other management. Two studies found that mature-forest species declined. One study found

no differences in species richness between treatments, another found no consistent differences. A study from the USA found that a mosaic of cut and uncut areas supported a variety of species. *Assessment: trade-offs between benefits and harms (effectiveness 55%; certainty 60%; harms 30%).*

http://www.conservationevidence.com/actions/326

Employ grazing in artificial grasslands/pastures

Five studies from the UK and USA found use or nesting densities were higher in grazed compared to ungrazed areas. A study from Canada found an increase in duck populations following the start of grazing along with other interventions. Eight studies from the UK, Canada and the USA found species richness, community composition, abundances, use, nesting densities, nesting success or productivity were similar or lower on grazed compared with ungrazed areas. One found that several species were excluded by grazing. *Assessment: trade-offs between benefits and harms (effectiveness 43%; certainty 65%; harms 45%).*

http://www.conservationevidence.com/actions/349

Employ grazing in natural grasslands

Five of 12 studies from the USA and Canada found that densities of some species were higher on grazed than ungrazed sites. Eight studies from the USA, Canada and France found that some or all species studied were found at similar or lower densities on grazed compared to ungrazed sites or those under other management. Two controlled studies from the USA and Canada found that nesting success was higher on grazed than ungrazed sites. Five studies from the USA and Canada found that nesting success was similar or lower on grazed sites. *Assessment: trade-offs between benefits and harms (effectiveness 40%; certainty 60%; harms 50%).*

http://www.conservationevidence.com/actions/348

Employ grazing in non-grassland habitats

One of eight studies found more bird species on grazed than unmanaged sites, apart from in drought years. A study from the Netherlands found the number of species in a mixed habitat wetland site declined with increased grazing. Three studies in Sweden, the Netherlands and Kenya found that the overall abundance or densities of some species were higher in grazed than ungrazed sites. Four studies in Europe and Kenya found that some species were absent or at lower densities on grazed compared to ungrazed sites or

those under different management. Five studies from across the world found no differences in abundances or densities of some or all species between grazed sites and those that were ungrazed or under different management. Two studies from the UK found that productivity was lower in grazed than ungrazed sites. A study from the UK found that songbirds and invertebrate-eating species, but not crows were more common on rough-grazed habitats than intensive pasture. *Assessment: trade-offs between benefits and harms (effectiveness 40%; certainty 67%; harms 40%).*

http://www.conservationevidence.com/actions/350

Manage water level in wetlands

Three studies (of six) from the USA, UK and Canada found that different species were more abundant at different water heights. One found that diversity levels also changed. One study found that great bitterns in the UK established territories earlier when deep water levels were maintained, but productivity did not vary. A study from Spain found that water management successfully retained water near a greater flamingo nesting area, but did not measure the effects on productivity or survival. *Assessment: trade-offs between benefits and harms (effectiveness 40%; certainty 41%; harms 35%).*

http://www.conservationevidence.com/actions/355

Manually control or remove midstorey and ground-level vegetation (including mowing, chaining, cutting etc.) in forests

Seven studies from Europe and the USA found that species richness, total density or densities of some species were higher in areas with mid- or understorey management compared to areas without management. Four studies also used other interventions. Seven studies from the USA and Canada found that species richness, densities, survival or competition for nest sites were similar or lower in areas with mid- or understorey control. Two studies investigated several interventions at once. Two studies from Canada found higher nest survival in forests with removal of deciduous trees compared to controls. One study found that chicks foraging success was higher in areas with cleared understorey vegetation compared to burned areas, but lower than under other managements. *Assessment: trade-offs between benefits and harms (effectiveness 40%; certainty 75%; harms 40%).*

http://www.conservationevidence.com/actions/335

Mow or cut natural grasslands

Two of six studies found higher densities of birds or nests on mown grasslands compared to unmanaged or burned areas. Two studies found lower densities or nests of some species and two found no differences in nesting densities or community composition on mown compared to unmown areas. One study from the USA found that grasshopper sparrow nesting success was higher on mown than grazed areas. One study from the USA found that duck nesting success was similar on cut and uncut areas. *Assessment: trade-offs between benefits and harms (effectiveness 40%; certainty 50%; harms 39%).*

http://www.conservationevidence.com/actions/338

Mow or cut semi-natural grasslands/pastures

One of four studies found that wader populations increased following annual cutting of semi-natural grasslands. One study from the UK found that ducks grazed at higher densities on cut areas. Another study in the UK found that goose grazing densities were unaffected by cutting frequency. One study from the USA found that Henslow's sparrows were more likely to be recaptured on unmown than mown grasslands. *Assessment: trade-offs between benefits and harms (effectiveness 40%; certainty 40%; harms 20%).*

http://www.conservationevidence.com/actions/339

Manually control or remove midstorey and ground-level vegetation (including mowing, chaining, cutting etc.) in shrublands

One of seven studies found that overall bird diversity and bird density was similar between chained areas, burned areas and controls. One found that overall diversity and abundance was lower on mown sites than controls, but that grassland-specialist species were present on managed sites. Five studies from the USA and Europe found than some species were at greater densities or abundances on sites with mechanical vegetation control than on sites with burning or no management. Three studies from the USA found that some species were less abundant on sites with mechanical vegetation removal. One study from the USA found no differences between areas cut in winter and summer. *Assessment: trade-offs between benefits and harms (effectiveness 43%; certainty 54%; harms 30%).*

http://www.conservationevidence.com/actions/337

Raise water levels in ditches or grassland

One of seven studies found that three waders were found to have recolonised a UK site or be found at very high densities after water levels were raised. Three studies from Europe found that raising water levels on grassland provided habitat for waders. A study from Denmark found that oystercatchers did not nest at higher densities on sites with raised water levels. A study from the UK found that birds visited sites with raised water levels more frequently than other fields, but another UK study found that feeding rates did not differ between sites with raised water levels and those without. A study from the USA found that predation rates on seaside sparrow nests increased as water levels were raised. *Assessment: trade-offs between benefits and harms (effectiveness 65%; certainty 55%; harms 25%).*

http://www.conservationevidence.com/actions/354

Thin trees within forests

One study of 14 (from the USA) found higher bird species richness in sites with tree thinning and several other interventions, compared to unmanaged sites. Three studies from the UK and USA found no such differences. Seven studies (four investigating multiple interventions) found that overall bird abundance or the abundance of some species was higher in thinned plots, compared to those under different management. Five studies found that found that abundances were similar, or that some species were less abundant in areas with thinning. Two studies from the USA found no effect of thinning on wood thrushes, a species thought to be sensitive to it. A study from the USA found that a higher proportion of nests were in nest boxes in a thinned site, compared to a control. A study from the USA found no differences in bird abundances between burned sites with high-retention thinning, compared to low-retention sites. *Assessment: trade-offs between benefits and harms (effectiveness 50%; certainty 60%; harms 30%).*

http://www.conservationevidence.com/actions/328

Use prescribed burning: grasslands

Four of 21 studies found that overall species richness and community composition did not vary between burned and unburned sites. Nine studies from across the world found that at least some species were more abundant or at higher densities in burned than unburned areas or areas under different management. Fourteen studies found that at least one species was at similar or lower abundances on burned areas. Responses varied depending on how

soon after fires monitoring occurred. One study from the USA found that Florida grasshopper sparrow had significantly higher reproductive success soon after burns, whilst another found that dickcissel reproductive success was higher in patch-burned than burned and grazed areas. *Assessment: trade-offs between benefits and harms (effectiveness 45%; certainty 60%; harms 40%).*

http://www.conservationevidence.com/actions/322

Use prescribed burning: pine forests

Four of 28 studies in the USA found higher species richness, densities or abundances in sites with prescribed burning, tree thinning and in one case mid- or understorey control compared to controls. Fourteen studies found that some species were more abundant, or had higher productivities or survival in burned or burned and thinned areas than control areas. One study found that effects varied with geography and habitat. Fifteen studies found no differences in species richness or densities, community composition, productivity, behaviour or survival between sites with prescribed burning or burning and thinning, and controls or sites with other management. One study found that foraging success of chicks was lower in burned areas. Three studies found effects did not vary with burn season. *Assessment: trade-offs between benefits and harms (effectiveness 50%; certainty 77%; harms 35%).*

http://www.conservationevidence.com/actions/318

Use prescribed burning: savannahs

One of five studies found that burned areas of savannah tended to have more birds and species than control or grazed areas, although burned sites showed significant annual variation unlike grazed sites. A study from Australia found that effects on bird abundances depended on burn season and habitat type. Two studies in the USA found that some open country species were more common in burned areas than unburned. A study from the USA found that two eastern bluebirds successfully raised chicks after a local prescribed burn. *Assessment: trade-offs between benefits and harms (effectiveness 40%; certainty 50%; harms 35%).*

http://www.conservationevidence.com/actions/320

Use prescribed burning: shrublands

One of eight studies found that overall bird densities were similar between burned and unburned areas, whilst another found that species numbers and

densities did not vary between areas burned in summer or winter. Three studies found that some species were more abundant on areas that were burned. Four found that species densities were similar or lower on burned compared to control areas or those under different management. One study found that sage sparrows chose different nest sites before and after burning. Another found no differences in greater sage grouse movement between burned and unburned areas. *Assessment: trade-offs between benefits and harms (effectiveness 43%; certainty 50%; harms 45%).*

http://www.conservationevidence.com/actions/321

Use selective harvesting/logging instead of clearcutting

Six of seven studies from the USA and Canada found that some species were more, and other less, abundant in selectively logged forests compared to unlogged stands, or those under other management. One study found that differences between treatments were not consistent. A study from the USA found that species richness of cavity-nesting birds was lower in selectively logged forests than in clearcuts. One study from the USA found that brood parasitism was higher in selectively logged forests for two species and lower for two others, compared to control stands. *Assessment: trade-offs between benefits and harms (effectiveness 65%; certainty 60%; harms 30%).*

http://www.conservationevidence.com/actions/331

Unknown effectiveness (limited evidence)

Clearcut and re-seed forests

One of two studies from the USA found that stands of pines replanted with native species held more species typical of scrub habitats than stands under different management. The other study found similar bird densities in clearcut and re-seeded sites and those under different management. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 35%; harms 0%).*

http://www.conservationevidence.com/actions/327

Coppice trees

One of three studies found a population increase in European nightjars on a UK site after the introduction of coppicing and other interventions. Two studies from the UK and USA found that the use of coppices by some bird

species declined over time. A UK study found that species richness decreased with the age of a coppice, but that some species were more abundant in older stands. *Assessment: unknown effectiveness — limited evidence (effectiveness 34%; certainty 30%; harms 30%).*

http://www.conservationevidence.com/actions/329

Fertilise grasslands

All four studies captured (all from the UK) found that more geese grazed on fertilised areas of grass more than control areas. Two investigated cutting and fertilizing at the same time. One study found that fertilised areas were used less than re-seeded areas. One study found that fertilisation had an effect at applications of 50 kg N/ha, but not at 18 kg N/ha. Another found that the effects of fertilisation did not increase at applications over 80 kg N/ha. *Assessment: unknown effectiveness — limited evidence (effectiveness 60%; certainty 35%; harms 7%).*

http://www.conservationevidence.com/actions/353

Manage woodland edges for birds

One of three studies found that a local population of European nightjars increased at a UK site following the start of a management regime that included the management of woodland edges for birds. Two studies of an experiment in the USA found that bird abundance (but not species richness or nesting success) was higher in woodland edges managed for wildlife than unmanaged edges. *Assessment: unknown effectiveness — limited evidence (effectiveness 55%; certainty 39%; harms 30%).*

http://www.conservationevidence.com/actions/334

Manually control or remove midstorey and ground-level vegetation (including mowing, chaining, cutting etc.) (reedbeds)

One of three studies found that warblers nested at lower densities in cut areas of reeds. Productivity and success did not vary between treatments. A study from Denmark found that geese grazed at the highest densities on reedbeds cut 5–12 years previously. One study in the UK found that cutting reeds and changing water levels did not affect great bittern breeding productivity, but did delay territory establishment. *Assessment: unknown effectiveness — limited evidence (effectiveness 15%; certainty 36%; harms 14%).*

http://www.conservationevidence.com/actions/340

Manually control or remove midstorey and ground-level vegetation (including mowing, chaining, cutting etc.) (savannahs)

A study in Argentina found that in summer, but not overall, bird abundance and species richness was lower in an area where shrubs were removed compared to a control. Community composition also differed between treatments. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 10%; harms 30%).*

http://www.conservationevidence.com/actions/336

Plant trees to act as windbreaks

One of two studies found that a population of European nightjars increased at a UK site after multiple interventions including the planting of windbreak trees. A study from the USA found that such trees appeared to disrupt lekking behaviour in greater prairie chickens. *Assessment: unknown effectiveness — limited evidence (effectiveness 12%; certainty 25%; harms 20%).*

http://www.conservationevidence.com/actions/351

Plough habitats

One of four studies found that bird densities were higher on ploughed wetlands in the USA than unploughed ones. Three studies of one experiment in the UK found that few whimbrels nested on areas of heathland ploughed and re-seeded, but that they were used for foraging in early spring. There were no differences in chick survival between birds that used ploughed and re-seeded heathland and those that did not. *Assessment: unknown effectiveness — limited evidence (effectiveness 25%; certainty 36%; harms 10%).*

http://www.conservationevidence.com/actions/358

Provide deadwood/snags in forests (adding woody debris to forests)

One study from Australia found that brown treecreeper numbers were higher in plots with large amounts of dead wood added compared to plots with less or no debris added. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 29%; harms 0%).*

http://www.conservationevidence.com/actions/344

Remove coarse woody debris from forests

Two studies from the USA found that some species increased in sites with woody debris removal. One found that overall breeding bird abundance and diversity were lower in removal plots; the other that survival of black-chinned hummingbird nests was lower. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 33%; harms 60%).*

http://www.conservationevidence.com/actions/345

Replace non-native species of tree/shrub

A study from the USA found that the number of black-chinned hummingbird nests increased after fuel reduction and the planting of native species, but that the increase was smaller than at sites without planting. *Assessment: unknown effectiveness — limited evidence (effectiveness 5%; certainty 18%; harms 0%).*

http://www.conservationevidence.com/actions/341

Re-seed grasslands

One of two studies from the UK found that geese grazed at higher densities on re-seeded grasslands than on control or fertilised grasslands. Another study from the UK found that geese grazed at higher densities on areas sown with clover, rather than grass seed. *Assessment: unknown effectiveness — limited evidence (effectiveness 35%; certainty 19%; harms 0%).*

http://www.conservationevidence.com/actions/352

Use environmentally sensitive flood management

One of two studies found more bird territories on a stretch of river in the UK with flood beams, compared to a channelized river. The other found that 13 out of 20 species of bird increased at sites in the USA where a river's hydrological dynamics were restored. *Assessment: unknown effectiveness — limited evidence (effectiveness 41%; certainty 26%; harms 0%).*

http://www.conservationevidence.com/actions/356

Use fire suppression/control

All three studies we captured, from the USA, UK and Australia, found that some bird species increased after fire suppression, and in one case that woodland species appeared in a site. Two studies (from the UK and USA) found that some species declined following fire suppression. The USA study identified open country species as being negatively affected. *Assessment: unknown effectiveness — limited evidence (effectiveness 35%; certainty 34%; harms 30%).*

http://www.conservationevidence.com/actions/324

Use greentree reservoir management

A study from the USA found that fewer mid- and under-storey birds were found at a greentree reservoir site than at a control site. Canopy-nesting species were not affected. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 10%; harms 40%).*

http://www.conservationevidence.com/actions/357

Use prescribed burning (Australian sclerophyll forest)

Two of three studies from Australia found no differences in bird species richness in burned sites compared to unburned areas. All three found differences in species assemblages, with some species lost and others gained from areas after fire. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 31%; harms 30%).*

http://www.conservationevidence.com/actions/319

Use shelterwood cutting instead of clearcutting

A study from the USA found that bird community composition differed between shelterwood stands and those under other forestry practices: some species were more abundant, others less so. *Assessment: unknown effectiveness — limited evidence (effectiveness 40%; certainty 20%; harms 40%).*

http://www.conservationevidence.com/actions/333

Use variable retention management during forestry operations

A study from the USA found that nine species were more abundant and five less so in stands under variable retention management, compared to unmanaged stands. *Assessment: unknown effectiveness — limited evidence (effectiveness 45%; certainty 20%; harms 25%).*

http://www.conservationevidence.com/actions/332

Likely to be ineffective or harmful

Apply herbicide to mid- and understorey vegetation

One of seven studies from North America found that bird species richness in a forest declined after deciduous trees were treated with herbicide. Three studies found increases in total bird densities, or those of some species, after

herbicide treatment, although one found no differences between treatment and control areas. One study found that densities of one species decreased and another remained steady after treatment. Three studies found that nest survival was lower in herbicide-treated areas and one found lower nesting densities. One study found that northern bobwhite chicks higher had foraging success in forest areas treated with herbicide compared to under other managements. *Assessment: likely to be ineffective or harmful (effectiveness 20%; certainty 50%; harms 60%).*

http://www.conservationevidence.com/actions/346

Treat wetlands with herbicides

All four studies from the USA found higher densities of birds in wetlands sprayed with herbicide, compared with unsprayed areas. Two found that some species were at lower densities compared to unsprayed areas or those under other management. *Assessment: likely to be ineffective or harmful (effectiveness 30%; certainty 42%; harms 40%).*

http://www.conservationevidence.com/actions/347

Use prescribed burning (coastal habitats)

One study from the USA found that breeding seaside sparrow numbers decreased the year a site was burned, but were higher than on an unburned site the following year. One study in Argentina found that tall-grass specialist species were lost from burned areas in the year of burning, but that some habitats recovered by the following year. One study from the USA found no differences in nest predation rates between burned and unburned areas for two years after burning. *Assessment: likely to be ineffective or harmful (effectiveness 20%; certainty 40%; harms 30%).*

http://www.conservationevidence.com/actions/323

Use prescribed burning (deciduous forests)

One of four studies found that bird species richness was similar in burned and unburned aspen forests, although relative abundances of some species changed. A study in the USA found no changes in community composition in oak and hickory forests following burning. One study in the USA found no differences in wood thrush nest survival in burned and unburned areas.

Another study in the USA found a reduction in black-chinned hummingbird nests following fuel reduction treatments including burning. *Assessments: likely to be ineffective or harmful (effectiveness 32%; certainty 60%; harms 30%).*

http://www.conservationevidence.com/actions/317

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Protect nest trees before burning

3.10 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	• Restore or create forests • Restore or create wetlands and marine habitats: restore or create inland wetlands
Likely to be beneficial	• Restore or create grassland • Restore or create traditional water meadows • Restore or create wetlands and marine habitats: restore or create coastal and intertidal wetlands
Unknown effectiveness (limited evidence)	• Restore or create shrubland • Restore or create wetlands and marine habitats: restore or create kelp forests • Restore or create wetlands and marine habitats: restore or create lagoons
No evidence found (no assessment)	• Restore or create savannahs • Revegetate gravel pits

Beneficial

Restore or create forests

Thirteen of 15 studies from across the world found that restored forests were similar to in-tact forests, that species returned to restored sites, that species recovered significantly better at restored than unrestored sites or that bird

species richness, diversity or abundances in restored forest sites increased over time. One study also found that restoration techniques themselves improved over time. Nine studies found that some species did not return to restored forests or were less common and a study found that territory densities decreased over time. A study from the USA found that no more birds were found in restored sites, compared with unrestored. One study investigated productivity and found it was similar between restored and intact forests. A study from the USA found that planting fast-growing species appeared to provide better habitat than slower-growing trees. *Assessment: beneficial (effectiveness 65%; certainty 76%; harms 0%).*

http://www.conservationevidence.com/actions/360

Restore or create wetlands and marine habitats (inland wetlands)

All eleven studies from the USA and Canada found that birds used restored or created wetlands. Two found that rates of use and species richness were similar or higher than on natural wetlands. One found that use was higher than on unrestored wetlands. Three studies from the USA and Puerto Rico found that restored wetlands held lower densities and fewer species or had similar productivity compared to natural wetlands. Two studies in the USA found that semi-permanent restored and larger wetlands were used more than temporary or seasonal or smaller ones. *Assessment: beneficial (effectiveness 70%; certainty 65%; harms 0%).*

http://www.conservationevidence.com/actions/366

Likely to be beneficial

Restore or create grassland

Three of 23 studies found that species richness on restored grasslands was higher than unrestored habitats, or similar to remnant grassland, and three found that target species used restored grassland. Two studies from the USA found that diversity or species richness fell after restoration or was lower than unrestored sites. Seven studies from the USA and UK found high use of restored sites, or that such sites held a disproportionate proportion of the local population of birds. Two studies found that densities or abundances were lower on restored than unrestored sites, potentially due to drought conditions in one case. Five studies found that at least some bird species had

higher productivities in restored sites compared to unrestored; had similar or higher productivities than natural habitats; or had high enough productivities to sustain populations. Three studies found that productivities were lower in restored than unrestored areas, or that productivities on restored sites were too low to sustain populations. A study from the USA found that older restored fields held more nests, but fewer species than young fields. Three studies found no differences between restoration techniques; two found that sowing certain species increased the use of sites by birds. *Assessment: likely to be beneficial (effectiveness 45%; certainty 70%; harms 0%).*

http://www.conservationevidence.com/actions/361

Restore or create traditional water meadows

Four out of five studies found that the number of waders or wildfowl on UK sites increased after the restoration of traditional water meadows. One study from Sweden found an increase in northern lapwing population after an increase in meadow management. One study found that lapwing productivity was higher on meadows than some habitats, but not others. *Assessment: likely to be beneficial (effectiveness 65%; certainty 50%; harms 0%).*

http://www.conservationevidence.com/actions/363

Restore or create wetlands and marine habitats (coastal and intertidal wetlands)

All six studies from the USA and UK found that bird species used restored or created wetlands. Two found that numbers and/or diversity were similar to in natural wetlands and one that numbers were higher than in unrestored sites. Three found that bird numbers on wetlands increased over time. Two studies from the UK found that songbirds and waders decreased following wetland restoration, whilst a study from the USA found that songbirds were more common on unrestored sites than restored wetlands. *Assessment: likely to be beneficial (effectiveness 65%; certainty 55%; harms 3%).*

http://www.conservationevidence.com/actions/367

Unknown effectiveness (limited evidence)

Restore or create shrubland

Three studies from the UK, USA and the Azores found local bird population increases after shrubland restoration. Two studies investigated multiple interventions and one found an increase from no birds to one or two pairs.

One study from the UK found that several interventions, including shrubland restoration, were negatively related to the number of young grey partridges per adult bird on sites. *Assessment: unknown effectiveness — limited evidence (effectiveness 25%; certainty 20%; harms 3%).*

http://www.conservationevidence.com/actions/364

Restore or create wetlands and marine habitats (kelp forests)

One study in the USA found that the densities of five of the nine bird species increased following kelp forest restoration. *Assessment: unknown effectiveness — limited evidence (effectiveness 60%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/368

Restore or create wetlands and marine habitats (lagoons)

One study in the UK found that large numbers of bird species used and bred in a newly-created lagoon. *Assessment: unknown effectiveness — limited evidence (effectiveness 61%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/369

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Restore or create savannahs
- Revegetate gravel pits

3.11 Threat: Invasive alien and other problematic species

This assessment method for this chapter is described in Walsh, J. C., Dicks, L. V. & Sutherland, W. J. (2015) The effect of scientific evidence on conservation practitioners' management decisions. Conservation Biology, 29: 88–98. No harms were assessed for sections 3.11.1, 3.11.2, 3.11,3 and 3.11.4.

3.11.1 Reduce predation by other species

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reducing predation by other species?	
Beneficial	• Control mammalian predators on islands • Remove or control predators to enhance bird populations and communities
Likely to be beneficial	• Control avian predators on islands
Unknown effectiveness (limited evidence)	• Control invasive ants on islands • Reduce predation by translocating predators
Evidence not assessed	• Control predators not on islands

Beneficial

Control mammalian predators on islands

Of the 33 studies from across the world, 16 described population increases or recolonisations in at least some of the sites studied and 18 found higher reproductive success or lower mortality (on artificial nests in one case). Two studies that investigated population changes found only partial increases, in black oystercatchers *Haematopus bachmani* and two gamebird species, respectively. Eighteen of the studies investigated rodent control; 12 cat *Felis catus* control and 6 various other predators including pigs *Sus scrofa* and red foxes *Vulpes*. The two that found only partial increases examined cat, fox and other larger mammal removal. *Assessment: beneficial (effectiveness 81%; certainty 78%).*

http://www.conservationevidence.com/actions/373

Remove or control predators to enhance bird populations and communities

Both a meta-analysis and a systematic review (both global) found that bird reproductive success increased with predator control and that either post-breeding or breeding-season populations increased. The systematic review found that post-breeding success increased with predator control on mainland, but not islands. *Assessment: beneficial (effectiveness 66%; certainty 71%).*

http://www.conservationevidence.com/actions/371

Likely to be beneficial

Control avian predators on islands

Seven out of ten studies from North America, Australia and Europe found that controlling avian predators led to increased population sizes, reduced mortality, increased reproductive success or successful translocation of seabirds on islands. Two controlled studies on European islands found little effect of controlling crows on reproductive success in raptors or gamebirds. One study in the UK found that numbers of terns and small gulls on gravel islands declined despite the attempted control of large gulls. *Assessment: likely to be beneficial (effectiveness 50%; certainty 45%).*

http://www.conservationevidence.com/actions/372

Unknown effectiveness (limited evidence)

Control invasive ants on islands

A single study in the USA found that controlling the invasive tropical fire ant *Solenopsis geminata*, but not the big-headed ant *Pheidole megacephala*, led to lower rates of injuries and temporarily higher fledging success than on islands without ant control. The authors note that very few chicks were injured by *P. megacephala* on either experimental or control islands. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 15%).*

http://www.conservationevidence.com/actions/383

Reduce predation by translocating predators

Two studies from France and the USA found local population increases or reduced predation following the translocation of predators away from an area. *Assessment: unknown effectiveness — limited evidence (effectiveness 27%; certainty 20%).*

http://www.conservationevidence.com/actions/393

Evidence not assessed

Control predators not on islands

A study from the UK found higher bird community breeding densities and fledging success rates in plots with red fox *Vulpes vulpes* and carrion crow *Corvus corone* control. Of the 25 taxa-specific studies, only five found evidence for population increases with predator control, whilst one found a population decrease (with other interventions also used); one found lower or similar survival, probably because birds took bait. Nineteen studies found some evidence for increased reproductive success or decreased predation with predator control, with three studies (including a meta-analysis) finding no evidence for higher reproductive success or predation with predator control or translocation from the study site. One other study found evidence for increases in only three of six species studied. Most studies studied the removal of a number of different mammals, although several also removed bird predators, mostly carrion crows and gulls *Larus* spp. *Assessment: this intervention has not been assessed.*

http://www.conservationevidence.com/actions/384

3.11.2 Reduce incidental mortality during predator eradication or control

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reducing incidental mortality during predator eradication or control predation	
Unknown effectiveness (limited evidence)	• Distribute poison bait using dispensers • Use coloured baits to reduce accidental mortality during predator control • Use repellents on baits
Evidence not assessed	• Do birds take bait designed for pest control?

Unknown effectiveness (limited evidence)

Distribute poison bait using dispensers

A study from New Zealand found that South Island robin survival was higher when bait for rats and mice was dispensed from feeders, compared to being scattered. *Assessment: unknown effectiveness — limited evidence (effectiveness 40%; certainty 25%).*

http://www.conservationevidence.com/actions/157

Use coloured baits to reduce accidental mortality during predator control

Two out of three studies found that dyed baits were consumed at lower rates by songbirds and kestrels. An *ex situ* study from Australia found that dyeing food did not reduce its consumption by bush thick-knees. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 30%).*

http://www.conservationevidence.com/actions/182

Use repellents on baits

A study in New Zealand found that repellents reduced the rate of pecking at baits by North Island robins. A study from the USA found that treating bait with repellents did not reduce consumption by American kestrels. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 10%).*

http://www.conservationevidence.com/actions/159

Evidence not assessed

Do birds take bait designed for pest control?

Two studies from New Zealand and Australia, one *ex situ*, found no evidence that birds took bait meant for pest control. *Assessment: this intervention has not been assessed.*

http://www.conservationevidence.com/actions/395

3.11.3 Reduce nest predation by excluding predators from nests or nesting areas

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reducing nest predation by excluding predators from nests or nesting areas	
Likely to be beneficial	• Physically protect nests from predators using non-electric fencing • Physically protect nests with individual exclosures/barriers or provide shelters for chicks • Protect bird nests using electric fencing • Use artificial nests that discourage predation
Unknown effectiveness (limited evidence)	• Guard nests to prevent predation • Plant nesting cover to reduce nest predation • Protect nests from ants • Use multiple barriers to protect nests • Use naphthalene to deter mammalian predators • Use snakeskin to deter mammalian nest predators
No evidence found (no assessment)	• Play spoken-word radio programs to deter predators • Use 'cat curfews' to reduce predation • Use lion dung to deter domestic cats • Use mirrors to deter nest predators • Use ultrasonic devices to deter cats
Evidence not assessed	• Can nest protection increase nest abandonment? • Can nest protection increase predation of adults and chicks?

Likely to be beneficial

Physically protect nests from predators using non-electric fencing

Two of four studies from the UK and the USA found that fewer nests failed or were predated when predator exclusion fences were erected. Two studies found that nesting and fledging success was no higher when fences were used, one found that hatching success was higher. *Assessment: likely to be beneficial (effectiveness 45%; certainty 48%).*

http://www.conservationevidence.com/actions/183

Physically protect nests with individual exclosures/ barriers or provide shelters for chicks

Nine of 23 studies found that fledging rates or productivity were higher for nests protected by individual barriers than for unprotected nests. Two found no higher productivity. Fourteen studies found that hatching rates or survival were higher, or that predation was lower for protected nests. Two found no differences between protected and unprotected nests and one found that adults were harassed by predators at protected nests. One study found that chick shelters were not used much and a review found that some exclosure designs were more effective than others. *Assessment: likely to be beneficial (effectiveness 50%; certainty 50%).*

http://www.conservationevidence.com/actions/397
http://www.conservationevidence.com/actions/398
http://www.conservationevidence.com/actions/399
http://www.conservationevidence.com/actions/400

Protect bird nests using electric fencing

Two of six studies found increased numbers of terns or tern nests following the erection of an electric fence around colonies. Five studies found higher survival or productivity of waders or seabirds when electric fences were used and one found lower predation by mammals inside electric fences. One study found that predation by birds was higher inside electric fences. *Assessment: likely to be beneficial (effectiveness 60%; certainty 59%).*

http://www.conservationevidence.com/actions/188

Use artificial nests that discourage predation

Three out of five studies from North America found lower predation rates or higher nesting success for wildfowl in artificial nests, compared with natural nests. An *ex situ* study found that some nest box designs prevented raccoons from entering. A study found that wood ducks avoided anti-predator nest boxes but only if given the choice of unaltered nest boxes. *Assessment: likely to be beneficial (effectiveness 59%; certainty 54%).*

http://www.conservationevidence.com/actions/402

Unknown effectiveness (limited evidence)

Guard nests to prevent predation

Nest guarding can be used as a response to a range of threats and is therefore discussed in 'General responses to small/declining populations — Guard nests'. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 30%).*

http://www.conservationevidence.com/actions/411

Plant nesting cover to reduce nest predation

Studies relevant to this intervention are discussed in 'Threat: Agriculture'. *Assessment: unknown effectiveness — limited evidence (effectiveness 28%; certainty 30%).*

http://www.conservationevidence.com/actions/405

Protect nests from ants

A study from the USA found that vireo nests protected from ants with a physical barrier and a chemical repellent had higher fledging success than unprotected nests. *Assessment: unknown effectiveness — limited evidence (effectiveness 45%; certainty 17%).*

http://www.conservationevidence.com/actions/410

Use multiple barriers to protect nests

One of two studies found that plover fledging success in the USA was no higher when an electric fence was erected around individual nest exclosures, compared to when just the exclosures were present. A study from the USA found that predation on chicks was lower when one of two barriers around

nests was removed early, compared to when it was left for three more days. *Assessment: unknown effectiveness — limited evidence (effectiveness 7%; certainty 17%).*

http://www.conservationevidence.com/actions/404

Use naphthalene to deter mammalian predators

A study from the USA found that predation rates on artificial nests did not differ when naphthalene moth balls were scattered around them. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 10%).*

http://www.conservationevidence.com/actions/408

Use snakeskin to deter mammalian nest predators

A study from the USA found that flycatcher nests were predated less frequently if they had a snakeskin wrapped around them. *Assessment: unknown effectiveness — limited evidence (effectiveness 33%; certainty 15%).*

http://www.conservationevidence.com/actions/406

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Play spoken-word radio programmes to deter predators
- Use 'cat curfews' to reduce predation
- Use lion dung to deter domestic cats
- Use mirrors to deter nest predators
- Use ultrasonic devices to deter cats

Evidence not assessed

Can nest protection increase nest abandonment?

One of four studies (from the USA) found an increase in abandonment after nest exclosures were used. Two studies from the USA and Sweden found no increases in abandonment when exclosures were used and a review from the USA found that some designs were more likely to cause abandonment than others. *Assessment: this intervention has not been assessed.*

http://www.conservationevidence.com/actions/401

Can nest protection increase predation of adults and chicks?

Four of five studies from the USA and Sweden found that predation on chicks and adults was higher when exclosures were used. One of these found that adults were harassed when exclosures were installed and the chicks rapidly predated when they were removed. One study from Sweden found that predation was no higher when exclosures were used. *Assessment: this intervention has not been assessed.*

http://www.conservationevidence.com/actions/403

3.11.4 Reduce mortality by reducing hunting ability or changing predator behaviour

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reducing mortality by reducing hunting ability or changing predator behaviour	
Unknown effectiveness (limited evidence)	• Reduce predation by translocating nest boxes • Use collar-mounted devices to reduce predation • Use supplementary feeding of predators to reduce predation
Unlikely to be beneficial	• Use aversive conditioning to reduce nest predation

Unknown effectiveness (limited evidence)

Reduce predation by translocating nest boxes

Two European studies found that predation rates were lower for translocated nest boxes than for controls. *Assessment: unknown effectiveness — limited evidence (effectiveness 48%; certainty 25%).*

http://www.conservationevidence.com/actions/420

Use collar-mounted devices to reduce predation

Two replicated randomised and controlled studies in the UK and Australia found that fewer birds were returned by cats wearing collars with anti-hunting devices, compared to cats with control collars. No differences were found between different devices. *Assessment: unknown effectiveness — limited evidence (effectiveness 48%; certainty 35%).*

http://www.conservationevidence.com/actions/416

Use supplementary feeding to reduce predation

One of three studies found that fewer grouse chicks were taken to harrier nests when supplementary food was provided to the harriers, but no effect on grouse adult survival or productivity was found. One study from the USA found reduced predation on artificial nests when supplementary food was provided. Another study from the USA found no such effect. *Assessment: unknown effectiveness — limited evidence (effectiveness 13%; certainty 20%).*

http://www.conservationevidence.com/actions/417

Unlikely to be beneficial

Use aversive conditioning to reduce nest predation

Nine out of 12 studies found no evidence for aversive conditioning or reduced nest predation after aversive conditioning treatment stopped. Ten studies found reduced consumption of food when it was treated with repellent chemicals, i.e. during the treatment. Three, all studying avian predators, found some evidence for reduced consumption after treatment but these were short-lived trials or the effect disappeared within a year. *Assessment: unlikely to be beneficial (effectiveness 9%; certainty 60%).*

http://www.conservationevidence.com/actions/418
http://www.conservationevidence.com/actions/419

3.11.5 Reduce competition with other species for food and nest sites

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reducing competition with other species for food and nest sites?	
Likely to be beneficial	• Reduce inter-specific competition for food by removing or controlling competitor species
Unknown effectiveness (limited evidence)	• Protect nest sites from competitors • Reduce competition between species by providing nest boxes • Reduce inter-specific competition for nest sites by modifying habitats to exclude competitor species • Reduce inter-specific competition for nest sites by removing competitor species: ground nesting seabirds • Reduce inter-specific competition for nest sites by removing competitor species: songbirds • Reduce inter-specific competition for nest sites by removing competitor species: woodpeckers

Likely to be beneficial

Reduce inter-specific competition for food by removing or controlling competitor species

Three out of four studies found that at least some of the target species increased following the removal or control of competitor species. Two studies found that some or all target species did not increase, or that there was no change in kleptoparasitic behaviour of competitor species after control efforts. *Assessment: likely to be beneficial (effectiveness 44%; certainty 40%; harms 0%).*

http://www.conservationevidence.com/actions/428

Unknown effectiveness (limited evidence)

Protect nest sites from competitors

Two studies from the USA found that red-cockaded woodpecker populations increased after the installation of 'restrictor plates' around nest holes to prevent larger woodpeckers for enlarging them. Several other interventions were used at the same time. A study from Puerto Rico found lower competition between species after nest boxes were altered. A study from the USA found weak evidence that exclusion devices prevented house sparrows from using nest boxes and another study from the USA found that fitting restrictor plates to red-cockaded woodpecker holes reduced the number that were enlarged by other woodpeckers. *Assessment: unknown effectiveness — limited evidence (effectiveness 39%; certainty 24%; harms 5%).*

http://www.conservationevidence.com/actions/426

Reduce competition between species by providing nest boxes

A study from the USA found that providing extra nest boxes did not reduce the rate at which common starlings usurped northern flickers from nests. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 16%; harms 0%).*

http://www.conservationevidence.com/actions/427

Reduce inter-specific competition for nest sites by modifying habitats to exclude competitor species

A study from the USA found that clearing midstorey vegetation did not reduce the occupancy of red-cockaded woodpecker nesting holes by southern flying squirrels. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 12%; harms 0%).*

http://www.conservationevidence.com/actions/425

Reduce inter-specific competition for nest sites by removing competitor species (ground nesting seabirds)

Four studies from Canada and the UK found increased tern populations following the control or exclusion of gulls, and in two cases with many additional interventions. Two studies from the UK and Canada found that controlling large gulls had no impact on smaller species. Two studies from the USA and UK found that exclusion devices successfully reduced the numbers

of gulls at sites, although one found that they were only effective at small colonies and the other found that methods varied in their effectiveness and practicality. *Assessment: unknown effectiveness — limited evidence (effectiveness 41%; certainty 31%; harms 14%).*

http://www.conservationevidence.com/actions/422

Reduce inter-specific competition for nest sites by removing competitor species (songbirds)

Two studies from Australia found increases in bird populations and species richness after control of noisy miners. A study from Italy found that blue tits nested in more nest boxes when hazel dormice were excluded from boxes over winter. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 22%; harms 0%).*

http://www.conservationevidence.com/actions/424

Reduce inter-specific competition for nest sites by removing competitor species (woodpeckers)

Two studies in the USA found red-cockaded woodpecker populations increased following the removal of southern flying squirrels, in one case along with other interventions. A third found that red-cockaded woodpecker reintroductions were successful when squirrels were controlled. One study found fewer holes were occupied by squirrels following control efforts, but that occupancy by red-cockaded woodpeckers was no higher. *Assessment: unknown effectiveness — limited evidence (effectiveness 34%; certainty 28%; harms 0%).*

http://www.conservationevidence.com/actions/423

3.11.6 Reduce adverse habitat alteration by other species

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reducing adverse habitat alteration by other species?	
Likely to be beneficial	• Control or remove habitat-altering mammals • Reduce adverse habitat alterations by excluding problematic species (terrestrial species)
Unknown effectiveness (limited evidence)	• Reduce adverse habitat alterations by excluding problematic species (aquatic species) • Remove problematic vegetation • Use buffer zones to reduce the impact of invasive plant control

Likely to be beneficial

Control or remove habitat-altering mammals

Four out of five studies from islands in the Azores and Australia found that seabird populations increased after rabbits or other species were removed, although three studied several interventions at the same time. Two studies from Australia and Madeira found that seabird productivity increased after rabbit and house mouse eradication. *Assessment: likely to be beneficial (effectiveness 61%; certainty 41%; harms 0%).*

http://www.conservationevidence.com/actions/431

Reduce adverse habitat alterations by excluding problematic species (terrestrial species)

Three studies from the USA and the UK found higher numbers of certain songbird species and higher species richness in these groups when deer were excluded from forests. Intermediate canopy-nesting species in the USA and common nightingales in the UK were the species to benefit. A study from Hawaii found mixed effects of grazer exclusion. *Assessment: likely to be beneficial (effectiveness 48%; certainty 40%; harms 0%).*

http://www.conservationevidence.com/actions/429

Unknown effectiveness (limited evidence)

Reduce adverse habitat alterations by excluding problematic species (aquatic species)

A study in the USA found that waterbirds preferentially used wetland plots from which grass carp were excluded but moved as these became depleted over the winter. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 14%; harms 0%).*

http://www.conservationevidence.com/actions/430

Remove problematic vegetation

One of four studies (from Japan) found an increase in a bird population following the removal of an invasive plant. One study from the USA found lower bird densities in areas where a problematic native species was removed. One study from Australia found the Gould's petrel productivity was higher following the removal of native bird-lime trees, and a study from New Zealand found that Chatham Island oystercatchers could nest in preferable areas of beaches after invasive marram grass was removed. *Assessment: unknown effectiveness — limited evidence (effectiveness 43%; certainty 23%; harms 0%).*

http://www.conservationevidence.com/actions/432

Use buffer zones to reduce the impact of invasive plant control

A study from the USA found that no snail kite nests (built above water in cattail and bulrush) were lost during herbicide spraying when buffer zones were established around nests. *Assessment: unknown effectiveness — limited evidence (effectiveness 40%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/433

3.11.7 Reduce parasitism and disease

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reducing parasitism and disease?	
Likely to be beneficial	• Remove/control adult brood parasites
Trade-off between benefit and harms	• Remove/treat endoparasites and diseases
Unknown effectiveness (limited evidence)	• Alter artificial nest sites to discourage brood parasitism • Exclude or control 'reservoir species' to reduce parasite burdens • Remove brood parasite eggs from target species' nests • Remove/treat ectoparasites to increase survival or reproductive success: reduce nest ectoparasites by providing beneficial nesting material
	• Remove/treat ectoparasites to increase survival or reproductive success: remove ectoparasites from feathers • Use false brood parasite eggs to discourage brood parasitism
Unlikely to be beneficial	• Remove/treat ectoparasites to increase survival or reproductive success: remove ectoparasites from nests

Likely to be beneficial

Remove/control adult brood parasites

One of 12 studies, all from the Americas, found that a host species population increased after control of the parasitic cowbird, two studies found no effect. Five studies found higher productivities or success rates when cowbirds were removed, five found that some or all measures of productivity were no different. Eleven studies found that brood parasitism rates were lower after cowbird control. *Assessment: likely to be beneficial (effectiveness 48%; certainty 61%; harms 0%).*

http://www.conservationevidence.com/actions/441

Trade-off between benefit and harms

Remove/treat endoparasites and diseases

Two out of five studies found that removing endoparasites increased survival in birds and one study found higher productivity in treated birds. Two studies found no evidence, or uncertain evidence, for increases in survival with treatment and one study found lower parasite burdens, but also lower survival in birds treated with antihelmintic drugs. *Assessment: trade-offs between benefits and harms (effectiveness 48%; certainty 51%; harms 37%).*

http://www.conservationevidence.com/actions/434

Unknown effectiveness (limited evidence)

Alter artificial nest sites to discourage brood parasitism

A replicated trial from Puerto Rico found that brood parasitism levels were extremely high across all nest box designs tested. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 13%; harms 0%).*

http://www.conservationevidence.com/actions/446

Exclude or control 'reservoir species' to reduce parasite burdens

One of two studies found increased chick production in grouse when hares (carries of louping ill virus) were culled in the area, although a comment on the paper disputes this finding. A literature review found no compelling evidence for the effects of hare culling on grouse populations. *Assessment: unknown effectiveness — limited evidence (effectiveness 13%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/435

Remove brood parasite eggs from target species' nests

One of two studies found lower rates of parasitism when cowbird eggs were removed from host nests. One study found that nests from which cowbird eggs were removed had lower success than parasitised nests. *Assessment: unknown effectiveness — limited evidence (effectiveness 24%; certainty 20%; harms 21%).*

http://www.conservationevidence.com/actions/443

Remove/treat ectoparasites to increase survival or reproductive success (provide beneficial nesting material)

A study in Canada found lower numbers of some, but not all, parasites in nests provided with beneficial nesting material, but that there was no effect on fledging rates or chick condition. *Assessment: unknown effectiveness — limited evidence (effectiveness 15%; certainty 13%; harms 0%).*

http://www.conservationevidence.com/actions/439

Remove/treat ectoparasites to increase survival or reproductive success (remove ectoparasites from feathers)

A study in the UK found that red grouse treated with spot applications had lower tick and disease burdens and higher survival than controls, whilst birds with impregnated tags had lower tick burdens only. A study in Hawaii found that CO2 was the most effective way to remove lice from feathers, although lice were not killed. *Assessment: unknown effectiveness — limited evidence (effectiveness 42%; certainty 16%; harms 0%).*

http://www.conservationevidence.com/actions/437

Use false brood parasite eggs to discourage brood parasitism

A study from the USA found that parasitism rates were lower for red-winged blackbird nests with false or real cowbird eggs placed in them, than for control nests. *Assessment: unknown effectiveness — limited evidence (effectiveness 35%; certainty 19%; harms 0%).*

http://www.conservationevidence.com/actions/444

Unlikely to be beneficial

Remove/treat ectoparasites to increase survival or reproductive success (remove ectoparasites from nests)

Six of the seven studies found lower infestation rates in nests treated for ectoparasites, one (that used microwaves to treat nests) did not find fewer parasites. Two studies from the USA found higher survival or lower abandonment in nests treated for ectoparasites, whilst seven studies from across the world found no differences in survival, fledging rates or productivity

between nests treated for ectoparasites and controls. Two of six studies found that chicks from nests treated for ectoparasites were in better condition than those from control nests. *Assessment: unlikely to be beneficial (effectiveness 25%; certainty 58%; harms 0%).*

http://www.conservationevidence.com/actions/438

3.11.8 Reduce detrimental impacts of other problematic species

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for reducing detrimental impacts of other problematic species?	
Unknown effectiveness (limited evidence)	• Use copper strips to exclude snails from nests

Unknown effectiveness (limited evidence)

Use copper strips to exclude snails from nests

A study from Mauritius found no mortality from snails invading echo parakeet nests after the installation of copper strips around nest trees. Before installation, four chicks were killed by snails. *Assessment: unknown effectiveness — limited evidence (effectiveness 47%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/447

3.12 Threat: Pollution

3.12.1 Industrial pollution

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for industrial pollution?	
Likely to be beneficial	• Use visual and acoustic 'scarers' to deter birds from landing on pools polluted by mining or sewage
Unknown effectiveness (limited evidence)	• Relocate birds following oil spills • Use repellents to deter birds from landing on pools polluted by mining
Unlikely to be beneficial	• Clean birds after oil spills

Likely to be beneficial

Use visual and acoustic 'scarers' to deter birds from landing on pools polluted by mining or sewage

Two studies from Australia and the USA found that deterrent systems reduced bird mortality on toxic pools. Four of five studies from the USA and Canada found that fewer birds landed on pools when deterrents were used, one found no effect. Two studies found that radar-activated systems were more effective than randomly-activated systems. One study found that loud noises were more effective than raptor models. *Assessment: likely to be beneficial (effectiveness 50%; certainty 46%; harms 0%).*

http://www.conservationevidence.com/actions/452

Unknown effectiveness (limited evidence)

Relocate birds following oil spills

A study from South Africa found that a high percentage of penguins relocated following an oil spill returned to and bred at their old colony. More relocated birds bred than oiled-and-cleaned birds. *Assessment: unknown effectiveness — limited evidence (effectiveness 39%; certainty 10%; harms 5%).*

http://www.conservationevidence.com/actions/449

Use repellents to deter birds from landing on pools polluted by mining

An *ex situ* study from the USA found that fewer common starlings consumed contaminated water laced with chemicals, compared to untreated water. *Assessment: unknown effectiveness — limited evidence (effectiveness 51%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/453

Unlikely to be beneficial

Clean birds after oil spills

Three studies from South Africa and Australia found high survival of oiled-and-cleaned penguins and plovers, but a large study from the USA found low survival of cleaned common guillemots. Two studies found that cleaned birds bred and had similar success to un-oiled birds. After a second spill, one study found that cleaned birds were less likely to breed. Two studies found that cleaned birds had lower breeding success than un-oiled birds. *Assessment: unlikely to be beneficial (effectiveness 30%; certainty 45%; harms 5%).*

http://www.conservationevidence.com/actions/448

3.12.2 Agricultural pollution

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for agricultural pollution?	
Likely to be beneficial	• Leave headlands in fields unsprayed (conservation headlands) • Provide food for vultures to reduce mortality from diclofenac • Reduce pesticide, herbicide and fertiliser use generally
Unknown effectiveness (limited evidence)	• Reduce chemical inputs in permanent grassland management • Restrict certain pesticides or other agricultural chemicals
No evidence found (no assessment)	• Make selective use of spring herbicides • Provide buffer strips along rivers and streams • Provide unfertilised cereal headlands in arable fields • Use buffer strips around in-field ponds • Use organic rather than mineral fertilisers

Likely to be beneficial

Leave headlands in fields unsprayed (conservation headlands)

Three studies from Europe found that several species were strongly associated with conservation headlands; two of these found that other species were not associated with them. A review from the UK found larger grey partridge populations on sites with conservation headlands. Three studies found higher grey partridge adult or chick survival on sites with conservation headlands, one found survival did not differ. Four studies found higher grey partridge productivity on sites with conservation headlands, two found similar productivities and one found a negative relationship between conservation headlands and the number of chicks per adult partridge. *Assessment: likely to be beneficial (effectiveness 70%; certainty 50%; harms 0%).*

http://www.conservationevidence.com/actions/461

Provide food for vultures to reduce mortality from diclofenac

A before-and-after trial in Pakistan found that oriental white-backed vulture mortality rates were significantly lower when supplementary food was provided, compared to when it was not. *Assessment: likely to be beneficial (effectiveness 60%; certainty 40%; harms 0%).*

http://www.conservationevidence.com/actions/456

Reduce pesticide, herbicide and fertiliser use generally

One of nine studies found that the populations of some species increased when pesticide use was reduced and other interventions used. Three studies found that some or all species were found at higher densities on reduced-input sites. Five found that some of all species were not at higher densities. A study from the UK found that grey partridge chicks had higher survival on sites with reduced pesticide input. Another found that partridge broods were smaller on such sites and there was no relationship between reduced inputs and survival or the ratio of young to old birds. *Assessment: likely to be beneficial (effectiveness 55%; certainty 55%; harms 3%).*

http://www.conservationevidence.com/actions/454

Unknown effectiveness (limited evidence)

Reduce chemical inputs in permanent grassland management

A study from the UK found that no more foraging birds were attracted to pasture plots with no fertiliser, compared to control plots. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/459

Restrict certain pesticides or other agricultural chemicals

A before-and-study from Spain found an increase in the regional griffon vulture population following the banning of strychnine, amongst several other interventions. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/455

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Make selective use of spring herbicides
- Provide buffer strips along rivers and streams
- Provide unfertilised cereal headlands in arable fields
- Use buffer strips around in-field ponds
- Use organic rather than mineral fertilisers

3.12.3 Air-borne pollutants

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for air-borne pollutants?	
Unknown effectiveness (limited evidence)	• Use lime to reduce acidification in lakes

Unknown effectiveness (limited evidence)

Use lime to reduce acidification in lakes

A study from Sweden found no difference in osprey productivity during a period of extensive liming of acidified lakes compared to two periods without liming. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/465

3.12.4 Excess energy

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for excess energy?	
Unknown effectiveness (limited evidence)	• Shield lights to reduce mortality from artificial lights • Turning off lights to reduce mortality from artificial lights • Use flashing lights to reduce mortality from artificial lights • Use lights low in spectral red to reduce mortality from artificial lights
No evidence found (no assessment)	• Reduce the intensity of lighthouse beams • Using volunteers to collect and rehabilitate downed birds

Unknown effectiveness (limited evidence)

Shield lights to reduce mortality from artificial lights

A study from the USA found that fewer shearwaters were downed when security lights were shielded, compared to nights with unshielded lights. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/469

Turning off lights to reduce mortality from artificial lights

A study from the UK found that fewer seabirds were downed when artificial (indoor and outdoor) lighting was reduced at night, compared to nights with normal lighting. *Assessment: unknown effectiveness — limited evidence (effectiveness 49%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/467

Use flashing lights to reduce mortality from artificial lights

A study from the USA found that fewer dead birds were found beneath aviation control towers with only flashing lights, compared to those with both flashing and continuous lights. *Assessment: unknown effectiveness — limited evidence (effectiveness 54%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/470

Use lights low in spectral red to reduce mortality from artificial lights

Two studies from Europe found that fewer birds were attracted to low-red lights (including green and blue lights), compared with the number expected, or the number attracted to white or red lights. *Assessment: unknown effectiveness — limited evidence (effectiveness 56%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/471

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Reduce the intensity of lighthouse beams
- Using volunteers to collect and rehabilitate downed birds

3.13 Threat: Climate change, extreme weather and geological events

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for climate change, extreme weather and geological events?	
Unknown effectiveness (limited evidence)	• Replace nesting habitats when they are washed away by storms • Water nesting mounds to increase incubation success in malleefowl

Unknown effectiveness (limited evidence)

Replace nesting habitats when they are washed away by storms

A before-and-after study found that a common tern colony increased following the replacement of nesting habitats, whilst a second found that a colony decreased. In both cases, several other interventions were used at the same time, making it hard to examine the effect of habitat provision. *Assessment: unknown effectiveness — limited evidence (effectiveness 8%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/474

Water nesting mounds to increase incubation success in malleefowl

A single small trial in Australia found that watering malleefowl nests increased their internal temperature but that a single application of water did not prevent the nests drying out and being abandoned during a drought. *Assessment: unknown effectiveness — limited evidence (effectiveness 9%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/473

3.14 General responses to small/declining populations

3.14.1 Inducing breeding, rehabilitation and egg removal

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for inducing breeding, rehabilitation and egg removal?	
Unknown effectiveness (limited evidence)	• Rehabilitate injured birds • Remove eggs from wild nests to increase reproductive output • Use artificial visual and auditory stimuli to induce breeding in wild populations

Unknown effectiveness (limited evidence)

Rehabilitate injured birds

Two studies of four studies from the UK and USA found that 25–40% of injured birds taken in by centres were rehabilitated and released. Three studies from the USA found that rehabilitated birds appeared to have high survival. One found that mortality rates were higher for owls than raptors. *Assessment: unknown effectiveness — limited evidence (effectiveness 36%; certainty 30%; harms 0%).*

http://www.conservationevidence.com/actions/476

Remove eggs from wild nests to increase reproductive output

A study from Canada found that whooping crane reproductive success was higher for nests with one or two eggs removed than for controls. A study from the USA found that removing bald eagle eggs did not appear to affect the wild population and a replicated study from Mauritius found that removing entire Mauritius kestrel clutches appeared to increase productivity more than removing individual eggs as they were laid. *Assessment: unknown effectiveness — limited evidence (effectiveness 24%; certainty 25%; harms 5%).*

http://www.conservationevidence.com/actions/477

Use artificial visual and auditory stimuli to induce breeding in wild populations

A small study from the British Virgin Islands found an increase in breeding behaviour after the introduction of visual and auditory stimulants. *Assessment: unknown effectiveness — limited evidence (effectiveness 19%; certainty 11%; harms 0%).*

http://www.conservationevidence.com/actions/475

3.14.2 Provide artificial nesting sites

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for providing artificial nesting sites?	
Beneficial	• Provide artificial nests: falcons • Provide artificial nests: owls • Provide artificial nests: songbirds • Provide artificial nests: wildfowl
Likely to be beneficial	• Clean artificial nests to increase occupancy or reproductive success • Provide artificial nests: burrow-nesting seabirds • Provide artificial nests: divers/loons • Provide artificial nests: ground- and tree-nesting seabirds • Provide artificial nests: oilbirds • Provide artificial nests: raptors • Provide artificial nests: wildfowl — artificial/ floating islands

Unknown effectiveness (limited evidence)	• Artificially incubate eggs or warm nests • Guard nests • Provide artificial nests: gamebirds • Provide artificial nests: grebes • Provide artificial nests: ibises and flamingos • Provide artificial nests: parrots • Provide artificial nests: pigeons • Provide artificial nests: rails • Provide artificial nests: rollers • Provide artificial nests: swifts • Provide artificial nests: trogons • Provide artificial nests: waders • Provide artificial nests: woodpeckers • Provide nesting habitat for birds that is safe from extreme weather • Provide nesting material for wild birds • Remove vegetation to create nesting areas • Repair/support nests to support breeding • Use differently-coloured artificial nests

Beneficial

Provide artificial nests (falcons)

Four studies from the USA and Europe found that local populations of falcons increased following the installation of artificial nesting sites. However, a study from Canada found no increase in the local population of falcons following the erection of nest boxes. Eight studies from across the world found that the success and productivity of falcons in nest boxes was higher than or equal to those in natural nests. Four studies from across the world found that productivity in nest boxes was lower than in natural nests, or that some falcons were evicted from their nests by owls. Four studies from across the world found no differences in productivity between nest box designs or positions, whilst two from Spain and Israel found that productivity in boxes varied between designs and habitats. Twenty-one studies from across the world found nest boxes were used by falcons, with one in the UK finding

that nest boxes were not used at all. Seven studies found that position or design affected use, whilst three found no differences between design or positioning. *Assessment: beneficial (effectiveness 65%; certainty 65%; harms 0%).*

http://www.conservationevidence.com/actions/489

Provide artificial nests (owls)

Three studies from the UK appeared to show increases in local populations of owls following the installation of artificial nests. Another UK study found that providing nesting sites when renovating buildings maintained owl populations, whilst they declined at sites without nests. Four studies from the USA and the UK found high levels of breeding success in artificial nests. Two studies from the USA and Hungary found lower productivity or fledgling survival from breeding attempts in artificial nests, whilst a study from Finland found that artificial nests were only successful in the absence of larger owls. Four studies from the USA and Europe found that artificial nests were used as frequently as natural sites. Five studies from across the world found that owls used artificial nests. Seven studies found that nest position or design affected occupancy or productivity. However four studies found occupancy and/or productivity did not differ between different designs of nest box. *Assessment: beneficial (effectiveness 65%; certainty 66%; harms 5%).*

http://www.conservationevidence.com/actions/490

Provide artificial nests (songbirds)

Only three out of 66 studies from across the world found low rates of nest box occupancy in songbirds. Low rates of use were seen in thrushes, crows, swallows and New World warblers. Thrushes, crows, finches, swallows, wrens, tits, Old World and tyrant flycatchers, New World blackbirds, sparrows, waxbills, starlings and ovenbirds all used nest boxes. Five studies from across the world found higher population densities or growth rates, and one study from the USA found higher species richness, in areas with nest boxes. Twelve studies from across the world found that productivity in nest boxes was higher than or similar to natural nests. One study found there were more nesting attempts in areas with more nest boxes, although a study from Canada found no differences in productivity between areas with different nest box densities. Two studies from Europe found lower predation of species using nest boxes but three studies from the USA found low production in nest boxes. Thirteen studies from across the world found

that use, productivity or usurpation rate varied with nest box design, whilst seven found no difference in occupation rates or success between different designs. Similarly, fourteen studies found different occupation or success rates depending on the position of artificial nest sites but two studies found no such differences. *Assessment: beneficial (effectiveness 67%; certainty 85%; harms 0%).*

http://www.conservationevidence.com/actions/498

Provide artificial nests (wildfowl)

Six studies from North America and Europe found that wildfowl populations increased with the provision of artificial nests, although one study from Finland found no increase in productivity in areas with nest boxes. Nine out of twelve studies from North America found that productivity was high in artificial nests. Two studies found that success for some species in nest boxes was lower than for natural nests. Nineteen studies from across the world found that occupancy rates varied from no use to 100% occupancy. Two studies found that occupancy rates were affected by design or positioning. Three studies from North America found that nest boxes could have other impacts on reproduction and behaviour. *Assessment: beneficial (effectiveness 62%; certainty 76%; harms 0%).*

http://www.conservationevidence.com/actions/482

Likely to be beneficial

Clean artificial nests to increase occupancy or reproductive success

Five out of ten studies from North America and Europe found that songbirds preferentially nested in cleaned nest boxes or those sterilised using microwaves, compared to used nest boxes. One study found that the preference was not strong enough for birds to switch nest boxes after they were settled. One study found that birds avoided heavily-soiled nest boxes. Two studies birds had a preference for used nest boxes and one found no preference for cleaned or uncleaned boxes. None of the five studies that examined it found any effect of nest box cleanliness on nesting success or parasitism levels. *Assessment: likely to be beneficial (effectiveness 40%; certainty 40%; harms 15%).*

http://www.conservationevidence.com/actions/499

Provide artificial nests (burrow-nesting seabirds)

Four studies from across the world found population increases or population establishment following the provision of nest boxes. In two cases this was combined with other interventions. Six studies from across the world found high occupancy rates for artificial burros by seabirds but three studies from across the world found very low occupancy rates for artificial burrows used by petrels. Eight studies from across the world found that the productivity of birds in artificial burrows was high although two studies from the USA and the Galapagos found low productivity in petrels. *Assessment: likely to be beneficial (effectiveness 60%; certainty 71%; harms 5%).*

http://www.conservationevidence.com/actions/481

Provide artificial nests (divers/loons)

Three studies from the UK and the USA found increases in loon productivity on lakes provided with nesting rafts. A study in the UK found that usage of nesting rafts varied between sites. *Assessment: likely to be beneficial (effectiveness 50%; certainty 50%; harms 0%).*

http://www.conservationevidence.com/actions/478

Provide artificial nests (ground- and tree-nesting seabirds)

Three studies from the UK and the Azores found increases in gull and tern populations following the provision of rafts/islands or nest boxes alongside other interventions. Five studies from Canada and Europe found that terns used artificial nesting sites. A study from the USA found that terns had higher nesting success on artificial rafts in some years and a study from Japan found increased nesting success after provision of nesting substrate. Design of nesting structure should be considered. *Assessment: likely to be beneficial (effectiveness 60%; certainty 49%; harms 0%).*

http://www.conservationevidence.com/actions/480

Provide artificial nests (oilbirds)

A study in Trinidad and Tobago found an increase in the size of an oilbird colony after the creation of artificial nesting lodges. *Assessment: likely to be beneficial (effectiveness 50%; certainty 45%; harms 0%).*

http://www.conservationevidence.com/actions/491

Provide artificial nests (raptors)

Nine studies from North America and Spain found that raptors used artificial nesting platforms. Two studies from the USA found increases in populations or densities following the installation of platforms. Three studies describe successful use of platforms but three found lower productivity or failed nesting attempts, although these studies only describe a single nesting attempt. *Assessment: likely to be beneficial (effectiveness 55%; certainty 55%; harms 0%).*

http://www.conservationevidence.com/actions/488

Provide artificial nests (wildfowl — artificial/floating islands)

Two studies from North America found that wildfowl used artificial islands and floating rafts and had high nesting success. A study in the UK found that wildfowl preferentially nested on vegetated rather than bare islands. *Assessment: likely to be beneficial (effectiveness 45%; certainty 45%; harms 0%).*

http://www.conservationevidence.com/actions/483

Unknown effectiveness (limited evidence)

Artificially incubate eggs or warm nests

One of two studies found that no kakapo chicks or eggs died of cold when they were artificially warmed when females left the nest. A study from the UK found that great tits were less likely to interrupt their laying sequence if their nest boxes were warmed, but there was no effect on egg or clutch size. *Assessment: unknown effectiveness — limited evidence (effectiveness 26%; certainty 16%; harms 0%).*

http://www.conservationevidence.com/actions/503

Guard nests

We captured four studies describing the effects of guarding nests. One, from Costa Rica, found an increase in scarlet macaw population after nest monitoring and several other interventions. Two studies from Puerto Rico and New Zealand found that nest success was higher, or mortality lower, when nests were monitored. A study from New Zealand found that nest success was high overall when nests were monitored. *Assessment: unknown effectiveness — limited evidence (effectiveness 41%; certainty 24%; harms 0%).*

http://www.conservationevidence.com/actions/506

Provide artificial nests (gamebirds)

A study in China found that approximately 40% of the local population of Cabot's tragopans used nesting platforms. *Assessment: unknown effectiveness — limited evidence (effectiveness 40%; certainty 13%; harms 0%).*

http://www.conservationevidence.com/actions/484

Provide artificial nests (grebes)

A study from the UK found that grebes used nesting rafts in some areas but not others. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 9%; harms 0%).*

http://www.conservationevidence.com/actions/479

Provide artificial nests (ibises and flamingos)

A study from Turkey found that ibises moved to a site with artificial breeding ledges. A study from Spain and France found that large numbers of flamingos used artificial nesting islands. *Assessment: unknown effectiveness — limited evidence (effectiveness 42%; certainty 31%; harms 0%).*

http://www.conservationevidence.com/actions/487

Provide artificial nests (parrots)

A study from Costa Rica found that the local population of scarlet macaws increased following the installation of nest boxes along with several other interventions. Five studies from South and Central America and Mauritius found that nest boxes were used by several species of parrots. One study from Peru found that blue-and-yellow macaws only used modified palms, not 'boxes', whilst another study found that scarlet macaws used both PVC and wooden boxes. Four studies from Venezuela and Columbia found that several species rarely, if ever, used nest boxes. Six studies from Central and South America found that parrots nested successfully in nest boxes, with two species showing higher levels of recruitment into the population following nest box erection and another finding that success rates for artificial nests were similar to natural nests. Three studies from South America found that artificial nests had low success rates, in two cases due to poaching. *Assessment: unknown effectiveness — limited evidence (effectiveness 25%; certainty 38%; harms 11%).*

http://www.conservationevidence.com/actions/497

Provide artificial nests (pigeons)

Two studies from the USA and the Netherlands found high use rates and high nesting success of pigeons and doves using artificial nests. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 16%; harms 0%).*

http://www.conservationevidence.com/actions/492

Provide artificial nests (rails)

A study from the UK found that common moorhens and common coot readily used artificial nesting islands. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 11%; harms 0%).*

http://www.conservationevidence.com/actions/485

Provide artificial nests (rollers)

A study from Spain found that the use of nest boxes by rollers increased over time and varied between habitats. Another study from Spain found no difference in success rates between new and old nest boxes. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/494

Provide artificial nests (swifts)

A study from the USA found that Vaux's swifts successfully used nest boxes provided. *Assessment: unknown effectiveness — limited evidence (effectiveness 25%; certainty 16%; harms 0%).*

http://www.conservationevidence.com/actions/495

Provide artificial nests (trogons)

A small study from Guatemala found that at least one resplendent quetzal nested in nest boxes provided. *Assessment: unknown effectiveness — limited evidence (effectiveness 19%; certainty 11%; harms 0%).*

http://www.conservationevidence.com/actions/493

Provide artificial nests (waders)

Two studies from the USA and the UK found that waders used artificial islands and nesting sites. *Assessment: unknown effectiveness — limited evidence (effectiveness 25%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/486

Provide artificial nests (woodpeckers)

Four studies from the USA found local increases in red-cockaded woodpecker populations or the successful colonisation of new areas following the installation of 'cavity inserts'. One study also found that the productivity of birds using the inserts was higher than the regional average. Two studies from the USA found that red-cockaded woodpeckers used cavity inserts, in one case more frequently than making their own holes or using natural cavities. One study from the USA found that woodpeckers roosted, but did not nest, in nest boxes. Five studies from the USA found that some woodpeckers excavated holes in artificial snags but only roosted in excavated holes or nest boxes. *Assessment: unknown effectiveness — limited evidence (effectiveness 35%; certainty 39%; harms 0%).*

http://www.conservationevidence.com/actions/496

Provide nesting habitat for birds that is safe from extreme weather

Two of three studies found that nesting success of waders and terns was no higher on raised areas of nesting substrate, with one finding that similar numbers were lost to flooding. The third study found that Chatham Island oystercatchers used raised nest platforms, but did not report on nesting success. *Assessment: unknown effectiveness — limited evidence (effectiveness 28%; certainty 23%; harms 0%).*

http://www.conservationevidence.com/actions/504

Provide nesting material for wild birds

One of two studies found that wild birds took nesting material provided; the other found only very low rates of use. *Assessment: unknown effectiveness — limited evidence (effectiveness 11%; certainty 9%; harms 0%).*

http://www.conservationevidence.com/actions/501

Remove vegetation to create nesting areas

Two out of six studies found increases in population sizes at seabird and wader colonies after vegetation was cleared and a third found that an entire colony moved to a new site that was cleared of vegetation. Two of these studies found that several interventions were used at once. Two studies found that gulls and terns used plots cleared of vegetation, one of these found that nesting densities were higher on partially-cleared plots than totally cleared, or uncleared, plots. One study found that tern nesting success was higher

on plots after they were cleared of vegetation and other interventions were used. *Assessment: unknown effectiveness — limited evidence (effectiveness 45%; certainty 28%; harms 10%).*

http://www.conservationevidence.com/actions/505

Repair/support nests to support breeding

A study from Puerto Rico found that no chicks died from chilling after nine nests were repaired to prevent water getting in. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/502

Use differently-coloured artificial nests

A study from the USA found that two bird species (a thrush and a pigeon) both showed colour preferences for artificial nests, but that these preferences differed between species. In each case, clutches in the preferred colour nest were less successful than those in the other colour. *Assessment: unknown effectiveness — limited evidence (effectiveness 3%; certainty 9%; harms 0%).*

http://www.conservationevidence.com/actions/500

3.14.3 Foster chicks in the wild

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for fostering chicks in the wild?	
Likely to be beneficial	• Foster eggs or chicks with wild conspecifics: raptors • Foster eggs or chicks with wild non-conspecifics (cross-fostering): songbirds
Unknown effectiveness (limited evidence)	• Foster eggs or chicks with wild conspecifics: bustards • Foster eggs or chicks with wild conspecifics: cranes • Foster eggs or chicks with wild conspecifics: gannets and boobies • Foster eggs or chicks with wild conspecifics: owls • Foster eggs or chicks with wild conspecifics: parrots • Foster eggs or chicks with wild conspecifics: vultures • Foster eggs or chicks with wild conspecifics: waders

	• Foster eggs or chicks with wild conspecifics: woodpeckers • Foster eggs or chicks with wild non-conspecifics (cross-fostering): cranes • Foster eggs or chicks with wild non-conspecifics (cross-fostering): ibises • Foster eggs or chicks with wild non-conspecifics (cross-fostering): petrels and shearwaters • Foster eggs or chicks with wild non-conspecifics (cross-fostering): waders

Likely to be beneficial

Foster eggs or chicks with wild conspecifics (raptors)

Ten out of 11 studies from across the world found that fostering raptor chicks to wild conspecifics had high success rates. A single study from the USA found that only one of six eggs fostered to wild eagle nests hatched and was raised. A study from Spain found that Spanish imperial eagle chicks were no more likely to survive to fledging if they were transferred to foster nests from three chick broods (at high risk from siblicide). A study from Spain found that young (15–20 day old) Montagu's harrier chicks were successfully adopted, but three older (27–29 day old) chicks were rejected. *Assessment: likely to be beneficial (effectiveness 70%; certainty 60%; harms 10%).*

http://www.conservationevidence.com/actions/510

Foster eggs or chicks with wild non-conspecifics (cross-fostering) (songbirds)

A study from the USA found that the survival of cross-fostered yellow warbler chicks was lower than previously-published rates for the species. A study from Norway found that the success of cross-fostering small songbirds varied depending on the species of chick and foster birds but recruitment was the same or higher than control chicks. The pairing success of cross-fostered chicks varied depending on species of chick and foster birds. *Assessment: likely to be beneficial (effectiveness 45%; certainty 45%; harms 10%).*

http://www.conservationevidence.com/actions/520

Unknown effectiveness (limited evidence)

Foster eggs or chicks with wild conspecifics (bustards)

A small study in Saudi Arabia found that a captive-bred egg was successfully fostered to a female in the wild. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 5%; harms 0%).*

http://www.conservationevidence.com/actions/513

Foster eggs or chicks with wild conspecifics (cranes)

A small study in Canada found high rates of fledging for whooping crane eggs fostered to first time breeders. *Assessment: unknown effectiveness — limited evidence (effectiveness 26%; certainty 11%; harms 0%).*

http://www.conservationevidence.com/actions/512

Foster eggs or chicks with wild conspecifics (gannets and boobies)

A small study in Australia found that gannet chicks were lighter, and hatching and fledging success lower in nests which had an extra egg or chick added. However, overall productivity was non-significantly higher in experimental nests. *Assessment: unknown effectiveness — limited evidence (effectiveness 9%; certainty 11%; harms 0%).*

http://www.conservationevidence.com/actions/507

Foster eggs or chicks with wild conspecifics (owls)

A study in the USA found high fledging rates for barn owl chicks fostered to wild pairs. A study from Canada found that captive-reared burrowing owl chicks fostered to wild nests did not have lower survival or growth rates than wild chicks. *Assessment: unknown effectiveness — limited evidence (effectiveness 35%; certainty 21%; harms 0%).*

http://www.conservationevidence.com/actions/511

Foster eggs or chicks with wild conspecifics (parrots)

A study from Venezuela found that yellow-shouldered Amazon chicks had high fledging rates when fostered to conspecific nests in the wild. A second study from Venezuela found lower poaching rates of yellow-shouldered Amazons when chicks were moved to foster nests closer to a field base. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 14%; harms 0%).*

http://www.conservationevidence.com/actions/515

Foster eggs or chicks with wild conspecifics (vultures)

Two small studies in Italy and the USA found that single chicks were successfully adopted by foster conspecifics, although in one case this led to the death of one of the foster parents' chicks. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 15%; harms 41%).*

http://www.conservationevidence.com/actions/509

Foster eggs or chicks with wild conspecifics (waders)

Two small trials in North America found that piping plovers accepted chicks introduced into their broods, although in one case the chick died. A study from New Zealand found that survival of fostered black stilts was higher for birds fostered to conspecifics rather than a closely related species. *Assessment: unknown effectiveness — limited evidence (effectiveness 29%; certainty 9%; harms 0%).*

http://www.conservationevidence.com/actions/508

Foster eggs or chicks with wild conspecifics (woodpeckers)

Three studies from the USA found that red-cockaded woodpecker chicks fostered to conspecifics had high fledging rates. One small study found that fostered chicks survived better than chicks translocated with their parents. *Assessment: unknown effectiveness — limited evidence (effectiveness 41%; certainty 29%; harms 0%).*

http://www.conservationevidence.com/actions/514

Foster eggs or chicks with wild non-conspecifics (cross-fostering) (cranes)

Two studies from the USA found low fledging success for cranes fostered to non-conspecifics' nests. *Assessment: unknown effectiveness — limited evidence (effectiveness 14%; certainty 35%; harms 10%).*

http://www.conservationevidence.com/actions/519

Foster eggs or chicks with wild non-conspecifics (cross-fostering) (ibises)

A 2007 literature review describes attempting to foster northern bald ibis chicks with cattle egrets as unsuccessful. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/518

Foster eggs or chicks with wild non-conspecifics (cross-fostering) (petrels and shearwaters)

A study from Hawaii found that Newell's shearwater eggs fostered to wedge-tailed shearwater nests had high fledging rates. *Assessment: unknown effectiveness — limited evidence (effectiveness 45%; certainty 6%; harms 0%).*

http://www.conservationevidence.com/actions/516

Foster eggs or chicks with wild non-conspecifics (cross-fostering) (waders)

A study from the USA found that killdeer eggs incubated and raised by spotted sandpipers had similar fledging rates to parent-reared birds. A study from New Zealand found that cross-fostering black stilt chicks to black-winged stilt nests increased nest success, but cross-fostered chicks had lower success than chicks fostered to conspecifics' nests. *Assessment: unknown effectiveness — limited evidence (effectiveness 35%; certainty 30%; harms 0%).*

http://www.conservationevidence.com/actions/517

3.14.4 Provide supplementary food

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for providing supplementary food?	
Beneficial	• Provide supplementary food to increase adult survival: songbirds
Likely to be beneficial	• Place feeders close to windows to reduce collisions • Provide calcium supplements to increase survival or reproductive success • Provide supplementary food to increase adult survival: cranes • Provide supplementary food to increase reproductive success: gulls, terns and skuas • Provide supplementary food to increase reproductive success: owls • Provide supplementary food to increase reproductive success: raptors • Provide supplementary food to increase reproductive success: songbirds

Unknown effectiveness (limited evidence)	• Provide perches to improve foraging success • Provide supplementary food through the establishment of food populations • Provide supplementary food to allow the rescue of a second chick • Provide supplementary food to increase adult survival: gamebirds • Provide supplementary food to increase adult survival: gulls, terns and skuas • Provide supplementary food to increase adult survival: hummingbirds • Provide supplementary food to increase adult survival: nectar-feeding songbirds • Provide supplementary food to increase adult survival: pigeons • Provide supplementary food to increase adult survival: raptors • Provide supplementary food to increase adult survival: vultures • Provide supplementary food to increase adult survival: waders • Provide supplementary food to increase adult survival: wildfowl • Provide supplementary food to increase adult survival: woodpeckers • Provide supplementary food to increase reproductive success: auks • Provide supplementary food to increase reproductive success: gamebirds • Provide supplementary food to increase reproductive success: gannets and boobies • Provide supplementary food to increase reproductive success: ibises • Provide supplementary food to increase reproductive success: kingfishers • Provide supplementary food to increase reproductive success: parrots • Provide supplementary food to increase reproductive success: petrels

	• Provide supplementary food to increase reproductive success: pigeons • Provide supplementary food to increase reproductive success: rails and coots • Provide supplementary food to increase reproductive success: vultures • Provide supplementary food to increase reproductive success: waders • Provide supplementary food to increase reproductive success: wildfowl • Provide supplementary water to increase survival or reproductive success

Beneficial

Provide supplementary food to increase adult survival (songbirds)

Seven studies from Europe and the USA found higher densities or larger populations of songbird species in areas close to supplementary food. Six studies from Europe, Canada and Japan found that population trends or densities were no different between fed and unfed areas. Four studies from around the world found that birds had higher survival when supplied with supplementary food. However, in two studies this was only apparent in some individuals or species and one study from the USA found that birds with feeding stations in their territories had lower survival. Six studies from Europe and the USA found that birds supplied with supplementary food were in better physical condition than unfed birds. However, in four studies this was only true for some individuals, species or seasons. Two studies investigated the effect of feeding on behaviours: one in the USA found that male birds spent more time singing when supplied with food and one in Sweden found no behavioural differences between fed and unfed birds. Thirteen studies from the UK, Canada and the USA investigated use of feeders. Four studies from the USA and the UK found high use of supplementary food, with up to 21% of birds' daily energy needs coming from feeders. However, another UK study found very low use of food. The timing of peak feeder use varied. Two trials from the UK found that the use of feeders increased with distance to houses and decreased with distance to cover. Two studies in Canada and the

UK, found that preferences for feeder locations and positions varies between species. *Assessment: beneficial (effectiveness 65%; certainty 75%; harms 0%).*

http://www.conservationevidence.com/actions/552

Likely to be beneficial

Place feeders close to windows to reduce collisions

A randomised, replicated and controlled study in the USA found that fewer birds hit windows, and fewer were killed, when feeders were placed close to windows, compared to when they were placed further away. *Assessment: likely to be beneficial (effectiveness 44%; certainty 43%; harms 0%).*

http://www.conservationevidence.com/actions/557

Provide calcium supplements to increase survival or reproductive success

Eight of 13 studies (including a literature review) from across the world found some positive effects of calcium provisioning on birds' productivites (six studies) or health (two studies). Six studies (including the review) found no evidence for positive effects on some of the species studied. One study from Europe found that birds at polluted sites took more calcium supplement than those at cleaner sites. *Assessment: likely to be beneficial (effectiveness 55%; certainty 50%; harms 0%).*

http://www.conservationevidence.com/actions/559

Provide supplementary food to increase adult survival (cranes)

A study from Japan and a global literature review found that local crane populations increased after the provision of supplementary food. *Assessment: likely to be beneficial (effectiveness 40%; certainty 40%; harms 15%).*

http://www.conservationevidence.com/actions/547

Provide supplementary food to increase reproductive success (gulls, terns and skuas)

Four studies of three experiments from Europe and Alaska found that providing supplementary food increased fledging success or chick survival in two gull species, although a study from the UK found that this was only true for one of two islands. One study from the Antarctic found no effect of feeding parent skuas on productivity. One study from Alaska found increased

chick growth when parents were fed but a study from the Antarctic found no such increase. *Assessment: likely to be beneficial (effectiveness 42%; certainty 41%; harms 0%).*

http://www.conservationevidence.com/actions/525

Provide supplementary food to increase reproductive success (owls)

Two replicated, controlled trials from Europe and the USA found that owls supplied with supplementary food had higher hatching and fledging rates. The European study, but not the American, also found that fed pairs laid earlier and had larger clutches. The study in the USA also found that owls were no more likely to colonise nest boxes provided with supplementary food. *Assessment: likely to be beneficial (effectiveness 50%; certainty 42%; harms 0%).*

http://www.conservationevidence.com/actions/533

Provide supplementary food to increase reproductive success (raptors)

A small study in Italy described a small increase in local kite populations following the installation of a feeding station. Four European studies found that kestrels and Eurasian sparrowhawks laid earlier than control birds when supplied with supplementary food. Three studies from the USA and Europe found higher chick survival or condition when parents were supplied with food, whilst three from Europe found fed birds laid larger clutches and another found that fed male hen harriers bred with more females than control birds. Four studies from across the world found no evidence that feeding increased breeding frequency, clutch size, laying date, eggs size or hatching or fledging success. A study from Mauritius found uncertain effects of feeding on Mauritius kestrel reproduction. There was some evidence that the impact of feeding was lower in years with peak numbers of prey species. *Assessment: likely to be beneficial (effectiveness 55%; certainty 52%; harms 0%).*

http://www.conservationevidence.com/actions/532

Provide supplementary food to increase reproductive success (songbirds)

Two studies from the USA found evidence for higher population densities of magpies and American blackbirds in areas provided with supplementary food, whilst two studies from the UK and Canada found that population densities were not affected by feeding. Twelve studies from across the world

found that productivity was higher for fed birds than controls. Eleven studies from Europe and the USA found that fed birds had the same, or even lower, productivity or chick survival than control birds. Nine studies from Europe and North America found that the eggs of fed birds were larger or heavier, or that the chicks of fed birds were in better physical condition. However, eight studies from across the world found no evidence for better condition or increased size in the eggs or chicks of fed birds. Six studies from across the world found that food-supplemented pairs laid larger clutches, whilst 14 studies from Europe and North America found that fed birds did not lay larger clutches. Fifteen studies from across the world found that birds supplied with supplementary food began nesting earlier than controls, although in two cases only certain individuals, or those in particular habitats, laid earlier. One study found that fed birds had shorter incubations than controls whilst another found that fed birds re-nested quicker and had shorter second incubations. Four studies from the USA and Europe found that fed birds did not lay any earlier than controls. Seven studies from across the world found that fed parent birds showed positive behavioural responses to feeding. However, three studies from across the world found neutral or negative responses to feeding. *Assessment: likely to be beneficial (effectiveness 51%; certainty 85%; harms 6%).*

http://www.conservationevidence.com/actions/537

Unknown effectiveness (limited evidence)

Provide perches to improve foraging success

One of four studies, from Sweden, found that raptors used clearcuts provided with perches more than clearcuts without perches. Two studies found that birds used perches provided, but a controlled study from the USA found that shrikes did not alter foraging behaviour when perches were present. *Assessment: unknown effectiveness — limited evidence (effectiveness 45%; certainty 30%; harms 0%).*

http://www.conservationevidence.com/actions/556

Provide supplementary food through the establishment of food populations

One of four studies that established prey populations found that wildfowl fed on specially-planted rye grass. Two studies found that cranes in the USA and owls in Canada did not respond to established prey populations. A study

from Sweden found that attempts to increase macroinvertebrate numbers for wildfowl did not succeed. *Assessment: unknown effectiveness — limited evidence (effectiveness 9%; certainty 26%; harms 0%)..*

http://www.conservationevidence.com/actions/555

Provide supplementary food to allow the rescue of a second chick

A study from Spain found that second chicks from lammergeier nests survived longer if nests were provided with food, in one case allowing a chick to be rescued. *Assessment: unknown effectiveness — limited evidence (effectiveness 15%; certainty 14%; harms 0%).*

http://www.conservationevidence.com/actions/541

Provide supplementary food to increase adult survival (gamebirds)

Two European studies found increased numbers of birds in fed areas, compared to unfed areas. There was only an increase in the overall population in the study area in one of these studies. Of four studies in the USA on northern bobwhites, one found that birds had higher overwinter survival in fed areas, one found lower survival, one found fed birds had higher body fat percentages and a literature review found no overall effect of feeding. *Assessment: unknown effectiveness — limited evidence (effectiveness 49%; certainty 38%; harms 0%).*

http://www.conservationevidence.com/actions/544

Provide supplementary food to increase adult survival (gulls, terns and skuas)

A study in the Antarctic found that fed female south polar skuas lost more weight whilst feeding two chicks than unfed birds. There was no difference for birds with single chicks, or male birds. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 20%; harms 10%).*

http://www.conservationevidence.com/actions/548

Provide supplementary food to increase adult survival (hummingbirds)

Four studies from the USA found that three species of hummingbird preferred higher concentrations of sucrose, consuming more and visiting feeders more frequently. A study from the USA found that hummingbirds

preferentially fed on sugar solutions over artificial sweeteners, and that the viscosity of these solutions did not affect their consumption. Two studies from Mexico and Argentina found that four species showed preferences for sucrose over fructose or glucose and sucrose over a sucrose-glucose mix, but no preference for sucrose over a glucose-fructose mix. A study from the USA found that birds showed a preference for red-dyed sugar solutions over five other colours. A study from the USA found that rufous hummingbirds preferentially fed on feeders that were placed higher. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 24%; harms 0%).*

http://www.conservationevidence.com/actions/550

Provide supplementary food to increase adult survival (nectar-feeding songbirds)

Two studies from Australia and New Zealand found that ten species of honeyeaters and stitchbirds readily used feeders supplying sugar solutions, with seasonal variations varying between species. A series of *ex situ* trials using southern African birds found that most species preferred sucrose solutions over glucose or fructose. One study found that sunbirds and sugarbirds only showed such a preference at low concentrations. Two studies found that two species showed preferences for sucrose when comparing 20% solutions, although a third species did not show this preference. All species rejected solutions with xylose added. A final study found that sucrose preferences were only apparent at equicalorific concentrations high enough for birds to subsist on. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 23%; harms 0%).*

http://www.conservationevidence.com/actions/553

Provide supplementary food to increase adult survival (pigeons)

The first of two studies of a recently-released pink pigeon population on Mauritius found that fewer than half the birds took supplementary food. However, the later study found that almost all birds used supplementary feeders. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 19%; harms 0%).*

http://www.conservationevidence.com/actions/549

Provide supplementary food to increase adult survival (raptors)

Two studies in the USA found that nesting northern goshawks were significantly heavier in territories supplied with supplementary food, compared with those from unfed territories. *Assessment: unknown effectiveness— limited evidence (effectiveness 30%; certainty 23%; harms 0%).*

http://www.conservationevidence.com/actions/546

Provide supplementary food to increase adult survival (vultures)

A study from Spain found a large increase in griffon vulture population in the study area following multiple interventions including supplementary feeding. Two studies from the USA and Israel found that vultures fed on the carcasses provided for them. In the study in Israel vultures were sometimes dominated by larger species at a feeding station supplied twice a month, but not at one supplied every day. *Assessment: unknown effectiveness — limited evidence (effectiveness 18%; certainty 18%; harms 0%).*

http://www.conservationevidence.com/actions/545

Provide supplementary food to increase adult survival (waders)

A study in Northern Ireland found that waders fed on millet seed when provided, but were dominated by other ducks when larger seeds were provided. *Assessment: unknown effectiveness — limited evidence (effectiveness 22%; certainty 9%; harms 0%).*

http://www.conservationevidence.com/actions/543

Provide supplementary food to increase adult survival (wildfowl)

Two studies from Canada and Northern Ireland found that five species of wildfowl readily consumed supplementary grains and seeds. The Canadian study found that fed birds were heavier and had larger hearts or flight muscles or more body fat than controls. *Assessment: unknown effectiveness — limited evidence (effectiveness 14%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/542

Provide supplementary food to increase adult survival (woodpeckers)

One replicated, controlled study from the USA found that 12 downy woodpeckers supplied with supplementary food had higher nutritional statuses than unfed birds. However, two analyses of a replicated, controlled study of 378 downy woodpeckers from the USA found that they did not have higher survival rates or nutritional statuses than unfed birds. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 30%; harms 0%).*

http://www.conservationevidence.com/actions/551

Provide supplementary food to increase reproductive success (auks)

Two replicated studies from the UK found that Atlantic puffin chicks provided with supplementary food were significantly heavier than control chicks, but fed chicks fledged at the same time as controls. A randomised, replicated and controlled study from Canada found that tufted puffin chicks supplied with supplementary food fledged later than controls and that fed chicks had faster growth by some, but not all, metrics. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 38%; harms 0%).*

http://www.conservationevidence.com/actions/524

Provide supplementary food to increase reproductive success (gamebirds)

A controlled study in Tibet found that Tibetan eared pheasants fed supplementary food laid significantly larger eggs and clutches than control birds. Nesting success and laying dates were not affected. *Assessment: unknown effectiveness — limited evidence (effectiveness 23%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/527

Provide supplementary food to increase reproductive success (gannets and boobies)

A small controlled study in Australia found that Australasian gannet chicks were significantly heavier if they were supplied with supplementary food, but only in one of two years. Fledging success of fed nests was also higher, but not significantly so. A randomised replicated and controlled study in the

Galapagos Islands found that fed female Nazca boobies were more likely to produce two-egg clutches, and that second eggs were significantly heavier. *Assessment: unknown effectiveness — limited evidence (effectiveness 33%; certainty 25%; harms 0%).*

http://www.conservationevidence.com/actions/523

Provide supplementary food to increase reproductive success (ibises)

A study from China found that breeding success of crested ibis was correlated with the amount of supplementary food provided, although no comparison was made with unfed nests. *Assessment: unknown effectiveness — limited evidence (effectiveness 25%; certainty 11%; harms 0%).*

http://www.conservationevidence.com/actions/530

Provide supplementary food to increase reproductive success (kingfishers)

A controlled study in the USA found that belted kingfishers supplied with food had heavier nestlings and were more likely to renest. There was mixed evidence for the effect of feeding on laying date. *Assessment: unknown effectiveness — limited evidence (effectiveness 33%; certainty 13%; harms 0%).*

http://www.conservationevidence.com/actions/534

Provide supplementary food to increase reproductive success (parrots)

Two studies from New Zealand found evidence that providing supplementary food for kakapos increased the number of breeding attempts made, whilst a third study found that birds provided with specially-formulated pellets appeared to have larger clutches than those fed on nuts. One study found no evidence that providing food increased the number of nesting attempts. *Assessment: unknown effectiveness — limited evidence (effectiveness 33%; certainty 11%; harms 0%).*

http://www.conservationevidence.com/actions/536

Provide supplementary food to increase reproductive success (petrels)

A replicated controlled study in Australia found that Gould's petrel chicks provided with supplementary food had similar fledging rates to both

control and hand-reared birds, but were significantly heavier than other birds. *Assessment: unknown effectiveness — limited evidence (effectiveness 19%; certainty 14%; harms 0%).*

http://www.conservationevidence.com/actions/522

Provide supplementary food to increase reproductive success (pigeons)

A study in the UK found no differences in reproductive parameters of European turtle doves between years when food was supplied and those when it was not. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 21%; harms 0%).*

http://www.conservationevidence.com/actions/535

Provide supplementary food to increase reproductive success (rails and coots)

A small trial in the USA found that fed American coots laid heavier eggs, but not larger clutches, than controls. However, a randomised, replicated and controlled study in Canada found that clutch size, but not egg size, was larger in fed American coot territories. The Canadian study also found that coots laid earlier when fed, whilst a replicated trial from the UK found there was a shorter interval between common moorhens clutches in fed territories, but that fed birds were no more likely to produce second broods. *Assessment: unknown effectiveness — limited evidence (effectiveness 33%; certainty 26%; harms 0%).*

http://www.conservationevidence.com/actions/528

Provide supplementary food to increase reproductive success (vultures)

Two studies from the USA and Greece found that there were local increases in two vulture populations following the provision of food in the area. A study from Israel found that a small, regularly supplied feeding station could provide sufficient food for breeding Egyptian vultures. A study from Italy found that a small population of Egyptian vultures declined following the provision of food, and only a single vulture was seen at the feeding station. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 24%; harms 0%).*

http://www.conservationevidence.com/actions/531

Provide supplementary food to increase reproductive success (waders)

A small controlled trial from the Netherlands found that Eurasian oystercatchers did not produce larger replacement eggs if provided with supplementary food. Instead their eggs were smaller than the first clutch, whereas control females laid larger replacement eggs. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/529

Provide supplementary food to increase reproductive success (wildfowl)

A small randomised controlled *ex situ* study from Canada found faster growth and higher weights for fed greater snow goose chicks than unfed ones, but no differences in mortality rates. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/526

Provide supplementary water to increase survival or reproductive success

A controlled study from Morocco found that northern bald ibises provided with supplementary water had higher reproductive success than those a long way from water sources. *Assessment: unknown effectiveness — limited evidence (effectiveness 43%; certainty 14%; harms 0%).*

http://www.conservationevidence.com/actions/558

3.14.5 Translocations

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for translocations?	
Beneficial	• Translocate birds to re-establish populations or increase genetic variation (birds in general) • Translocate birds to re-establish populations or increase genetic variation: raptors

Likely to be beneficial	• Translocate birds to re-establish populations or increase genetic variation: parrots • Translocate birds to re-establish populations or increase genetic variation: pelicans • Translocate birds to re-establish populations or increase genetic variation: petrels and shearwaters • Translocate birds to re-establish populations or increase genetic variation: rails • Translocate birds to re-establish populations or increase genetic variation: songbirds • Translocate birds to re-establish populations or increase genetic variation: wildfowl • Translocate birds to re-establish populations or increase genetic variation: woodpeckers • Use decoys to attract birds to new sites • Use techniques to increase the survival of species after capture • Use vocalisations to attract birds to new sites
Trade-off between benefit and harms	• Translocate birds to re-establish populations or increase genetic variation: gamebirds
Unknown effectiveness (limited evidence)	• Alter habitats to encourage birds to leave • Ensure translocated birds are familiar with each other before release • Translocate birds to re-establish populations or increase genetic variation: auks • Translocate birds to re-establish populations or increase genetic variation: herons, storks and ibises • Translocate birds to re-establish populations or increase genetic variation: megapodes • Translocate birds to re-establish populations or increase genetic variation: owls • Translocate nests to avoid disturbance
No evidence found (no assessment)	• Ensure genetic variation to increase translocation success

Beneficial

Translocate birds to re-establish populations or increase genetic variation (birds in general)

A review of 239 bird translocation programmes found 63–67% resulted in establishment of a self-sustaining population. *Assessment: beneficial (effectiveness 64%; certainty 65%; harms 0%).*

http://www.conservationevidence.com/actions/566

Translocate birds to re-establish populations or increase genetic variation (raptors)

Six studies of three translocation programmes in the UK and the USA found that all successfully established populations of white-tailed eagles, red kites and ospreys. A study in Spain found high survival of translocated Montagu's harrier fledglings. *Assessment: beneficial (effectiveness 65%; certainty 66%; harms 0%).*

http://www.conservationevidence.com/actions/574

Likely to be beneficial

Translocate birds to re-establish populations or increase genetic variation (parrots)

Three studies of two translocation programmes from the Pacific and New Zealand found that populations of parrots successfully established on islands after translocation. Survival of translocated birds ranged from 41% to 98% globally. Despite high survival, translocated kakapos in New Zealand had very low reproductive output. *Assessment: likely to be beneficial (effectiveness 50%; certainty 60%; harms 10%).*

http://www.conservationevidence.com/actions/578

Translocate birds to re-establish populations or increase genetic variation (pelicans)

Two reviews of a pelican translocation programme in the USA found high survival of translocated nestlings and rapid target population growth. Some growth may have been due to additional immigration from the source populations. *Assessment: likely to be beneficial (effectiveness 55%; certainty 49%; harms 0%).*

http://www.conservationevidence.com/actions/569

Translocate birds to re-establish populations or increase genetic variation (petrels and shearwaters)

Three studies from Australia and New Zealand found that colonies of burrow-nesting petrels and shearwaters were successfully established following the translocation and hand-rearing of chicks. *Assessment: likely to be beneficial (effectiveness 60%; certainty 50%; harms 0%).*

http://www.conservationevidence.com/actions/568

Translocate birds to re-establish populations or increase genetic variation (rails)

Three studies of two translocation programmes in the Seychelles and New Zealand found high survival rates among translocated rail. All three studies round that the birds bred successfully. *Assessment: likely to be beneficial (effectiveness 54%; certainty 44%; harms 14%).*

http://www.conservationevidence.com/actions/573

Translocate birds to re-establish populations or increase genetic variation (songbirds)

Nine studies from across the world, including a review of 31 translocation attempts, found that translocations led to the establishment of songbird populations. Eight studies were on islands. Three studies reported on translocations that failed to establish populations. One study found nesting success decreased as the latitudinal difference between source area and release site increased. *Assessment: likely to be beneficial (effectiveness 50%; certainty 68%; harms 0%).*

http://www.conservationevidence.com/actions/580

Translocate birds to re-establish populations or increase genetic variation (wildfowl)

Three studies of two duck translocation programmes in New Zealand and Hawaii found high survival, breeding and successful establishment of new populations. However a study in the USA found that no ducks stayed at the release site and there was high mortality after release. A study in the USA found wing-clipping prevented female ducks from abandoning their ducklings. *Assessment: likely to be beneficial (effectiveness 42%; certainty 50%; harms 19%).*

http://www.conservationevidence.com/actions/571

Translocate birds to re-establish populations or increase genetic variation (woodpeckers)

Six studies of four programmes found that >50% translocated birds remained at their new sites, and two studies reported large population increases. Birds from four programmes were reported as forming pairs or breeding and one study round translocated nestlings fledged at similar rates to native chicks. All studies were of red-cockaded woodpeckers. *Assessment: likely to be beneficial (effectiveness 51%; certainty 42%; harms 0%).*

http://www.conservationevidence.com/actions/577

Use decoys to attract birds to new sites

Ten studies found that birds nested in areas where decoys were placed or that more birds landed in areas with decoys than control areas. Six studies used multiple interventions at once. One study found that three-dimensional models appeared more effective than two-dimensional ones, and that plastic models were more effective than rag decoys. *Assessment: likely to be beneficial (effectiveness 51%; certainty 45%; harms 0%).*

http://www.conservationevidence.com/actions/586

Use techniques to increase the survival of species after capture

A study from the USA found that providing dark, quiet environments with readily-available food and water increased the survival of small songbirds after capture and the probability that they would adapt to captivity. A study from the USA found that keeping birds warm during transit increased survival. *Assessment: likely to be beneficial (effectiveness 49%; certainty 41%; harms 0%).*

http://www.conservationevidence.com/actions/581

Use vocalisations to attract birds to new sites

Seven out of ten studies from around the world found that seabirds were more likely to nest or land to areas where vocalisations were played, or moved to new nesting areas after vocalisations were played. Four of these studied multiple interventions at once. Three studies found that birds were no more likely to nest or land in areas where vocalisations were played. *Assessment: likely to be beneficial (effectiveness 45%; certainty 50%; harms 0%).*

http://www.conservationevidence.com/actions/585

Trade-off between benefit and harms

Translocate birds to re-establish populations or increase genetic variation (gamebirds)

Three studies from the USA found that translocation of gamebirds led to population establishment or growth or an increase in lekking sites. Four studies from the USA found that translocated birds had high survival, but two found high mortality in translocated birds. Four studies from the USA found breeding rates among translocated birds were high or similar to resident birds. *Assessment: trade-offs between benefits and harms (effectiveness 50%; certainty 47%; harms 35%).*

http://www.conservationevidence.com/actions/572

Unknown effectiveness (limited evidence)

Alter habitats to encourage birds to leave

A study from Canada found that an entire Caspian tern population moved after habitat was altered at the old colony site, alongside several other interventions. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/587

Ensure translocated birds are familiar with each other before release

Two studies from New Zealand found no evidence that ensuring birds were familiar with each other increased translocation success. *Assessment: unknown effectiveness — limited evidence (effectiveness 0%; certainty 33%; harms 0%).*

http://www.conservationevidence.com/actions/582

Translocate birds to re-establish populations or increase genetic variation (auks)

A study in the USA and Canada found that 20% of translocated Atlantic puffins remained in or near the release site, with up to 7% breeding. *Assessment: unknown effectiveness — limited evidence (effectiveness 36%; certainty 38%; harms 0%).*

http://www.conservationevidence.com/actions/570

Translocate birds to re-establish populations or increase genetic variation (herons, storks and ibises)

A study in the USA found that a colony of black-crowned night herons was successfully translocated and bred the year after translocation. *Assessment: unknown effectiveness — limited evidence (effectiveness 44%; certainty 3%; harms 0%).*

http://www.conservationevidence.com/actions/575

Translocate birds to re-establish populations or increase genetic variation (megapodes)

A study from Indonesia found that up to 78% maleo eggs hatched after translocation. *Assessment: unknown effectiveness — limited evidence (effectiveness 49%; certainty 29%; harms 0%).*

http://www.conservationevidence.com/actions/567

Translocate birds to re-establish populations or increase genetic variation (owls)

A small study from New Zealand found that translocating two male boobooks allowed the establishment of a population when they interbred with a Norfolk Island boobook. A study in the USA found high survival amongst burrowing owls translocated as juveniles, although birds were not seen after release. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 19%; harms 0%).*

http://www.conservationevidence.com/actions/576

Translocate nests to avoid disturbance

All five studies captured found some success in relocating nests while they were in use, but one found that fewer than half of the burrowing owls studied were moved successfully; a study found that repeated disturbance caused American kestrels to abandon their nest and a study found that one barn swallow abandoned its nest after it was moved. *Assessment: unknown effectiveness — limited evidence (effectiveness 24%; certainty 39%; harms 30%).*

http://www.conservationevidence.com/actions/584

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Ensure genetic variation to increase translocation success.

3.15 Captive breeding, rearing and releases (*ex situ* conservation)

3.15.1 Captive breeding

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for captive breeding?	
Likely to be beneficial	• Artificially incubate and hand-rear birds in captivity: raptors • Artificially incubate and hand-rear birds in captivity: seabirds • Artificially incubate and hand-rear birds in captivity: songbirds • Artificially incubate and hand-rear birds in captivity: waders • Use captive breeding to increase or maintain populations: raptors
Unknown effectiveness (limited evidence)	• Artificially incubate and hand-rear birds in captivity: bustards • Artificially incubate and hand-rear birds in captivity: cranes • Artificially incubate and hand-rear birds in captivity: gamebirds • Artificially incubate and hand-rear birds in captivity: parrots • Artificially incubate and hand-rear birds in captivity: penguins • Artificially incubate and hand-rear birds in captivity: rails • Artificially incubate and hand-rear birds in captivity: storks and ibises

	• Artificially incubate and hand-rear birds in captivity: vultures • Artificially incubate and hand-rear birds in captivity: wildfowl • Freeze semen for artificial insemination • Use artificial insemination in captive breeding • Use captive breeding to increase or maintain populations: bustards • Use captive breeding to increase or maintain populations: cranes • Use captive breeding to increase or maintain populations: pigeons • Use captive breeding to increase or maintain populations: rails • Use captive breeding to increase or maintain populations: seabirds • Use captive breeding to increase or maintain populations: songbirds • Use captive breeding to increase or maintain populations: storks and ibises • Use captive breeding to increase or maintain populations: tinamous • Use puppets to increase the success of hand-rearing • Wash contaminated semen and use it for artificial insemination
Evidence not assessed	• Can captive breeding have deleterious effects on individual fitness?

Likely to be beneficial

Artificially incubate and hand-rear birds in captivity (raptors)

Six studies from across the world found high success rates for artificial incubation and hand-rearing of raptors. A replicated and controlled study from France found that artificially incubated raptor eggs had lower hatching success than parent-incubated eggs but fledging success for hand-reared

chicks was similar to wild chicks. A study from Canada found that hand-reared chicks had slower growth and attained a lower weight than parent-reared birds. A replicated study from Mauritius found that hand-rearing of wild eggs had higher success than hand-rearing captive-bred chicks. Three studies that provided methodological comparisons reported that incubation temperature affected hatching success and adding saline to the diet of falcon chicks increased their weight gain. *Assessment: likely to be beneficial (effectiveness 60%; certainty 52%; harms 5%).*

http://www.conservationevidence.com/actions/614

Artificially incubate and hand-rear birds in captivity (seabirds)

Five studies from across the world found evidence for the success of hand-rearing seabirds. One small study in Spain found that one of five hand-reared Audouin's gulls successfully bred in the wild. Four studies found that various petrel species successfully fledged after hand-rearing. One controlled study found that fledging rates of hand-reared birds was similar to parent-reared birds, although a study on a single bird found that the chick fledged at a lower weight and later than parent-reared chicks. *Assessment: likely to be beneficial (effectiveness 67%; certainty 45%; harms 2%).*

http://www.conservationevidence.com/actions/604

Artificially incubate and hand-rear birds in captivity (songbirds)

Four studies from the USA found high rates of success for artificial incubation and hand-rearing of songbirds. One study found that crow chicks fed more food had higher growth rates, but these rates never matched those of wild birds. *Assessment: likely to be beneficial (effectiveness 51%; certainty 44%; harms 1%).*

http://www.conservationevidence.com/actions/616

Artificially incubate and hand-rear birds in captivity (waders)

Three out of four replicated and controlled studies from the USA and New Zealand found that artificially incubated and/or hand-reared waders had higher hatching and fledging success than controls. One study from New Zealand found that hatching success of black stilt was lower for artificially-

incubated eggs. *Assessment: likely to be beneficial (effectiveness 64%; certainty 41%; harms 4%).*

http://www.conservationevidence.com/actions/611

Use captive breeding to increase or maintain populations (raptors)

Three small studies and a review from around the world found that raptors bred successfully in captivity. Two of these studies found that wild-caught birds bred in captivity after a few years, with one pair of brown goshawks producing 15 young over four years, whilst a study on bald eagle captive breeding found low fertility in captive-bred eggs, but that birds still produced chicks after a year. A review of Mauritius kestrel captive breeding found that 139 independent young were raised over 12 years from 30 eggs and chicks taken from the wild. An update of the same programme found that hand-reared Mauritius kestrels were less successful if they came from captive-bred eggs compared to wild 'harvested' eggs. *Assessment: likely to be beneficial (effectiveness 50%; certainty 41%; harms 10%).*

http://www.conservationevidence.com/actions/596

Unknown effectiveness (limited evidence)

Artificially incubate and hand-rear birds in captivity (bustards)

Two reviews of a houbara bustard captive breeding programme in Saudi Arabia found no difference in survival between artificially and parentally incubated eggs, and that removing eggs from clutches as they were laid increased the number laid by females. *Assessment: unknown effectiveness — limited evidence (effectiveness 31%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/610

Artificially incubate and hand-rear birds in captivity (cranes)

Two studies from the USA found that hand-reared birds showed normal reproductive behaviour and higher survival than parent-reared birds. *Assessment: unknown effectiveness — limited evidence (effectiveness 76%; certainty 31%; harms 0%).*

http://www.conservationevidence.com/actions/609

Artificially incubate and hand-rear birds in captivity (gamebirds)

A study in Finland found that hand-reared grey partridges did not take off to fly as effectively as wild-caught birds, potentially making them more vulnerable to predation. *Assessment: unknown effectiveness — limited evidence (effectiveness 11%; certainty 10%; harms 50%).*

http://www.conservationevidence.com/actions/607

Artificially incubate and hand-rear birds in captivity (parrots)

Two studies from South America describe the successful hand-rearing of parrot chicks. A review of the kakapo management programme found that chicks could be successfully raised and released, but that eggs incubated from a young age had low success. A study from the USA found that all hand-reared thick-billed parrots died within a month of release: significantly lower survival than for wild-caught birds translocated to the release site. *Assessment: unknown effectiveness — limited evidence (effectiveness 19%; certainty 30%; harms 11%).*

http://www.conservationevidence.com/actions/615

Artificially incubate and hand-rear birds in captivity (penguins)

Two replicated and controlled studies from South Africa found that hand-reared and released African penguins had similar survival and breeding success as birds which were not hand-reared. *Assessment: unknown effectiveness — limited evidence (effectiveness 41%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/605

Artificially incubate and hand-rear birds in captivity (rails)

A controlled study from New Zealand found that post-release survival of hand-reared takahe was as high as wild-reared birds and that six of ten released females raised chicks. *Assessment: unknown effectiveness — limited evidence (effectiveness 64%; certainty 13%; harms 0%).*

http://www.conservationevidence.com/actions/608

Artificially incubate and hand-rear birds in captivity (storks and ibises)

A small study in the USA describes the successful artificial incubation and hand-rearing of two Abdim's stork chicks, whilst a review of northern bald ibis conservation found that only very intensive rearing of a small number of chicks appeared to allow strong bonds, thought to be important for the successful release of birds into the wild, to form between chicks. *Assessment: unknown effectiveness — limited evidence (effectiveness 18%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/612

Artificially incubate and hand-rear birds in captivity (vultures)

A study in Peru found that hand-reared Andean condors had similar survival to parent-reared birds after release into the wild. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/613

Artificially incubate and hand-rear birds in captivity (wildfowl)

Two studies in Canada and India found high success rates for hand-rearing buffleheads and bar-headed geese in captivity. Eggs were artificially incubated or incubated under foster parents. A replicated, controlled study in England found that Hawaiian geese (nene) chicks showed less well-adapted behaviours if they were raised without parental contact. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 20%; harms 10%).*

http://www.conservationevidence.com/actions/606

Freeze semen for artificial insemination

Two small trials from the USA found that using thawed frozen semen for artificial insemination resulted in low fertility rates. A small trial from the USA found that a cryprotectant increased fertility rates achieved using frozen semen. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 10%; harms 45%).*

http://www.conservationevidence.com/actions/602

Use artificial insemination in captive breeding

A replicated study from Saudi Arabia found that artificial insemination could increase fertility in houbara bustards. A study of the same programme and a review found that repeated inseminations increased fertility, with the review arguing that artificial insemination had the potential to be a useful technique. Two studies from the USA found that artificially-inseminated raptors had either zero fertility, or approximately 50%. *Assessment: unknown effectiveness — limited evidence (effectiveness 33%; certainty 21%; harms 0%).*

http://www.conservationevidence.com/actions/601

Use captive breeding to increase or maintain populations (bustards)

Four studies of a captive breeding programme in Saudi Arabia reported that the houbara bustard chicks were successfully raised in captivity, with 285 chicks hatched in the 7th year of the project after 232 birds were used to start the captive population. Captive birds bred earlier and appeared to lay more eggs than wild birds. Forty-six percent of captive eggs hatched and 43% of chicks survived to ten years old. *Assessment: unknown effectiveness — limited evidence (effectiveness 41%; certainty 16%; harms 5%).*

http://www.conservationevidence.com/actions/592

Use captive breeding to increase or maintain populations (cranes)

A study from Canada over 32 years found that whooping cranes successfully bred in captivity eight years after the first eggs were removed from the wild. *Assessment: unknown effectiveness — limited evidence (effectiveness 51%; certainty 17%; harms 6%).*

http://www.conservationevidence.com/actions/591

Use captive breeding to increase or maintain populations (pigeons)

A review of a captive-breeding programme on Mauritius and in the UK found that 42 pink pigeons were successfully bred in captivity. *Assessment: unknown effectiveness — limited evidence (effectiveness 69%; certainty 21%; harms 0%).*

http://www.conservationevidence.com/actions/597

Use captive breeding to increase or maintain populations (rails)

A study from Australia found that three pairs of Lord Howe Islandwoodhens successfully bred in captivity, with 66 chicks being produced over four years. *Assessment: unknown effectiveness — limited evidence (effectiveness 26%; certainty 11%; harms 5%).*

http://www.conservationevidence.com/actions/590

Use captive breeding to increase or maintain populations (seabirds)

A study from Spain found that a single pair of Audouin's gulls successfully bred in captivity. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 4%; harms 5%).*

http://www.conservationevidence.com/actions/589

Use captive breeding to increase or maintain populations (songbirds)

Three studies from Australia and the USA found that three species of songbird bred successfully in captivity. Four out of five pairs of wild-bred, hand-reared puaiohi formed pairs and laid a total of 39 eggs and a breeding population of helmeted honeyeaters was successfully established through a breeding programme. Only one pair of loggerhead shrikes formed pairs from eight wild birds caught and their first clutch died. *Assessment: unknown effectiveness — limited evidence (effectiveness 77%; certainty 31%; harms 5%).*

http://www.conservationevidence.com/actions/598

Use captive breeding to increase or maintain populations (storks and ibises)

We captured a small study and a review both from the USA describing the captive breeding of storks. The study found that a pair bred; the review found that only seven of 19 species had been successfully bred in captivity. A review of bald ibis conservation found that 1,150 birds had been produced in captivity from 150 founders over 20 years. However, some projects had failed, and a study from Turkey found that captive birds had lower productivity than wild birds. *Assessment: unknown effectiveness — limited evidence (effectiveness 31%; certainty 30%; harms 8%).*

http://www.conservationevidence.com/actions/595

Use captive breeding to increase or maintain populations (tinamous)

A replicated study from Costa Rica found that great tinamous successfully bred in captivity, with similar reproductive success to wild birds. *Assessment: unknown effectiveness — limited evidence (effectiveness 51%; certainty 15%; harms 5%).*

http://www.conservationevidence.com/actions/588

Use puppets to increase the success of hand-rearing

Three studies from the USA and Saudi Arabia found that crows and bustards raised using puppets did not have higher survival, dispersal or growth than chicks hand-reared conventionally. *Assessment: unknown effectiveness — limited evidence (effectiveness 4%; certainty 20%; harms 0%).*

http://www.conservationevidence.com/actions/617

Wash contaminated semen and use it for artificial insemination

A replicated, controlled study from Spain found that washed, contaminated semen could be used to successfully inseminate raptors. *Assessment: unknown effectiveness — limited evidence (effectiveness 31%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/603

Evidence not assessed

Can captive breeding have deleterious effects?

We captured no studies investigating the effects of captive-breeding on fitness. Three studies using wild and captive populations or museum specimens found physiological or genetic changes in populations that had been bred in captivity. One found that changes were more likely to be caused by extremely low population levels than by captivity.

http://www.conservationevidence.com/actions/599

3.15.2 Release captive-bred individuals

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for captive breeding?	
Likely to be beneficial	• Provide supplementary food after release • Release captive-bred individuals into the wild to restore or augment wild populations: cranes • Release captive-bred individuals into the wild to restore or augment wild populations: raptors • Release captive-bred individuals into the wild to restore or augment wild populations: songbirds • Release captive-bred individuals into the wild to restore or augment wild populations: vultures
Unknown effectiveness (limited evidence)	• Clip birds' wings on release • Release birds as adults or sub-adults not juveniles • Release birds in groups • Release captive-bred individuals into the wild to restore or augment wild populations: bustards • Release captive-bred individuals into the wild to restore or augment wild populations: gamebirds • Release captive-bred individuals into the wild to restore or augment wild populations: owls • Release captive-bred individuals into the wild restore or augment wild populations: parrots • Release captive-bred individuals into the wild to restore or augment wild populations: pigeons • Release captive-bred individuals into the wild to restore or augment wild populations: rails • Release captive-bred individuals into the wild to restore or augment wild populations: storks and ibises • Release captive-bred individuals into the wild to restore or augment wild populations: waders • Release captive-bred individuals into the wild to restore or augment wild populations: wildfowl • Release chicks and adults in 'coveys' • Use 'anti-predator training' to improve survival after release

	• Use appropriate populations to source released populations • Use 'flying training' before release • Use holding pens at release sites • Use microlites to help birds migrate

Likely to be beneficial

Provide supplementary food after release

All three studies captured found that released birds used supplementary food provided. One study from Australia found that malleefowl had higher survival when provided with food and a study from Peru found that supplementary food could be used to increase the foraging ranges of Andean condors after release. *Assessment: likely to be beneficial (effectiveness 45%; certainty 48%; harms 0%).*

http://www.conservationevidence.com/actions/639

Release captive-bred individuals into the wild to restore or augment wild populations (cranes)

Four studies of five release programmes from the USA and Russia found that released cranes had high survival or bred in the wild. Two studies from two release programmes in the USA found low survival of captive-bred eggs fostered to wild birds compared with wild eggs, or a failure to increase the wild flock size. A worldwide review found that releases of migratory species were more successful if birds were released into existing flocks, and for non-migratory populations. One study from the USA found that birds released as sub-adults had higher survival than birds cross-fostered to wild birds. *Assessment: likely to be beneficial (effectiveness 55%; certainty 50%; harms 5%).*

http://www.conservationevidence.com/actions/621

Release captive-bred individuals into the wild to restore or augment wild populations (raptors)

Five studies of three release programmes from across the world found the establishment or increase of wild populations of falcons. Five studies from the USA found high survival of released raptors although one study from Australia found that a wedge-tailed eagle had to be taken back into

captivity after acting aggressively towards humans, and another Australian study found that only one of 15 brown goshawks released was recovered. *Assessment: likely to be beneficial (effectiveness 69%; certainty 56%; harms 10%).*

http://www.conservationevidence.com/actions/626

Release captive-bred individuals into the wild to restore or augment wild populations (songbirds)

A study in Mauritius describes the establishment of a population of Mauritius fody following the release of captive-bred individuals. Four studies of three release programmes on Hawaii found high survival of all three species released, with two thrush species successfully breeding. A replicated, controlled study from the USA found that shrike pairs with captive-bred females had lower reproductive success than pairs where both parents were wild-bred. *Assessment: likely to be beneficial (effectiveness 42%; certainty 40%; harms 5%).*

http://www.conservationevidence.com/actions/630

Release captive-bred individuals into the wild to restore or augment wild populations (vultures)

Four studies of two release programmes found that release programmes led to large population increases in Andean condors in Colombia and griffon vultures in France. A small study in Peru found high survival of released Andean condors over 18 months, with all fatalities occurring in the first six months after release. *Assessment: likely to be beneficial (effectiveness 73%; certainty 54%; harms 0%).*

http://www.conservationevidence.com/actions/625

Unknown effectiveness (limited evidence)

Clip birds' wings on release

Two of four studies found that bustards and geese had lower survival when released into holding pens with clipped wings compared to birds released without clipped wings. One study found no differences in survival for clipped or unclipped northern bald ibis. One study found that adult geese released with clipped wings survived better than geese released before they were able to fly. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 30%; harms 5%).*

http://www.conservationevidence.com/actions/633

Release birds as adults or sub-adults not juveniles

Three out of nine studies from across the world found that birds released as sub-adults had higher survival than those released as juveniles. Two studies found lower survival of wing-clipped sub-adult geese and bustards, compared with juveniles and one study found lower survival of all birds released as sub-adults, compared to those released as juveniles. Three studies found no differences in survival for birds released at different ages, although one found higher reproduction in birds released at greater ages. *Assessment: unknown effectiveness — limited evidence (effectiveness 35%; certainty 15%; harms 19%).*

http://www.conservationevidence.com/actions/636

Release birds in groups

A study from New Zealand found that released stilts were more likely to move long distances after release if they were released in larger groups. *Assessment: unknown effectiveness — limited evidence (effectiveness 32%; certainty 26%; harms 2%).*

http://www.conservationevidence.com/actions/634

Release captive-bred individuals into the wild to restore or augment wild populations (bustards)

Three reviews of a release programme for houbara bustard in Saudi Arabia found low initial survival of released birds, but the establishment of a breeding population and an overall success rate of 41%. The programme tested many different release techniques, the most successful of which was release of sub-adults, which were able to fly, into a large exclosure. *Assessment: unknown effectiveness — limited evidence (effectiveness 34%; certainty 26%; harms 5%).*

http://www.conservationevidence.com/actions/622

Release captive-bred individuals into the wild to restore or augment wild populations (gamebirds)

One of five studies from across the world found that releasing gamebirds established a population or bolstered an existing population. A review of a reintroduction programme in Pakistan found some breeding success in released cheer pheasants, but habitat change at the release site then excluded released birds. Three studies from Europe and the USA found that released birds had low survival, low reproductive success and no impact on the wild

population. *Assessment: unknown effectiveness — limited evidence (effectiveness 5%; certainty 35%; harms 1%).*

http://www.conservationevidence.com/actions/619

Release captive-bred individuals into the wild to restore or augment wild populations (owls)

A study in the USA found that a barn owl population was established following the release of 157 birds in the area over three years. A replicated, controlled study in Canada found that released burrowing owls had similar reproductive output but higher mortality than wild birds. *Assessment: unknown effectiveness — limited evidence (effectiveness 24%; certainty 15%; harms 0%).*

http://www.conservationevidence.com/actions/627

Release captive-bred individuals into the wild to restore or augment wild populations (parrots)

A study from Venezuela found that the population of yellow-shouldered amazons increased significantly following the release of captive-bred birds along with other interventions. A study in Costa Rica and Peru found high survival and some breeding of scarlet macaw after release. Three replicated studies in the USA, Dominican Republic and Puerto Rico found low survival in released birds, although the Puerto Rican study also found that released birds bred successfully. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 30%; harms 3%).*

http://www.conservationevidence.com/actions/629

Release captive-bred individuals into the wild to restore or augment wild populations (pigeons)

A single review of a captive-release programme in Mauritius found that that released pink pigeons had a first year survival of 36%. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 5%; harms 1%).*

http://www.conservationevidence.com/actions/628

Release captive-bred individuals into the wild to restore or augment wild populations (rails)

One study from Australia found that released Lord Howe Island woodhens successfully bred in the wild, re-establishing a wild population and a study from the UK found high survival of released corncrake in the first summer

after release. A replicated study in New Zealand found very low survival of North Island weka following release, mainly due to predation. *Assessment: unknown effectiveness — limited evidence (effectiveness 26%; certainty 16%; harms 0%).*

http://www.conservationevidence.com/actions/620

Release captive-bred individuals into the wild to restore or augment wild populations (storks and ibises)

A replicated study and a review of northern bald ibis release programmes in Europe and the Middle East found that only one of four resulted in a wild population being established or supported, with many birds dying or dispersing, rather than forming stable colonies. *Assessment: unknown effectiveness — limited evidence (effectiveness 20%; certainty 20%; harms 2%).*

http://www.conservationevidence.com/actions/624

Release captive-bred individuals into the wild to restore or augment wild populations (waders)

A review of black stilt releases in New Zealand found that birds had low survival (13–20%) and many moved away from their release sites. *Assessment: unknown effectiveness — limited evidence (effectiveness 10%; certainty 5%; harms 15%).*

http://www.conservationevidence.com/actions/623

Release captive-bred individuals into the wild to restore or augment wild populations (wildfowl)

Two studies of reintroduction programmes of ducks in New Zealand found high survival of released birds and population establishment. A study from Alaska found low survival of released cackling geese, but the population recovered from 1,000 to 6,000 birds after releases and the control of mammalian predators. A review of a reintroduction programme from Hawaii found that the release of Hawaiian geese (nene) did not result in the establishment of a self-sustaining population. Two studies from Canada found very low return rates for released ducks with one finding no evidence for survival of released birds over two years, although there was some evidence that breeding success was higher for released birds than wild ones. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 24%; harms 0%).*

http://www.conservationevidence.com/actions/618

Release chicks and adults in 'coveys'

Two out of three studies found that geese and partridges released in coveys had higher survival than young birds released on their own or adults released in pairs. A study from Saudi Arabia found that bustard chicks had low survival when released in coveys with flightless females. *Assessment: unknown effectiveness — limited evidence (effectiveness 40%; certainty 36%; harms 6%).*

http://www.conservationevidence.com/actions/635

Use 'anti-predator training' to improve survival after release

Both studies captured found higher survival for birds given predator training before release, compared with un-trained birds. One found that using a live fox, but not a model, for training increased survival in bustards, but that several birds were injured during training. *Assessment: unknown effectiveness — limited evidence (effectiveness 50%; certainty 20%; harms 9%).*

http://www.conservationevidence.com/actions/637

Use appropriate populations to source released populations

Two studies from Europe found that birds from populations near release sites adapted better and in one case had higher reproductive productivity than those from more distant populations. *Assessment: unknown effectiveness — limited evidence (effectiveness 53%; certainty 31%; harms 0%).*

http://www.conservationevidence.com/actions/631

Use 'flying training' before release

A study from the Dominican Republic found that parrots had higher first-year survival if they were given pre-release flying training. *Assessment: unknown effectiveness — limited evidence (effectiveness 30%; certainty 10%; harms 0%).*

http://www.conservationevidence.com/actions/638

Use holding pens at release sites

Three of four studies from North America and Saudi Arabia found that birds released into holding pens were more likely to form pairs or had higher survival than birds released into the open. One study found that parrots released into pens had lower survival than those released without preparation. A review of northern bald ibis releases found that holding pens could be

used to prevent birds from migrating from the release site and so increase survival. *Assessment: unknown effectiveness — limited evidence (effectiveness 51%; certainty 36%; harms 2%).*

http://www.conservationevidence.com/actions/632

Use microlites to help birds migrate

A study from Europe found that northern bald ibises followed a microlite south in the winter but failed to make the return journey the next year. *Assessment: unknown effectiveness — limited evidence (effectiveness 3%; certainty 5%; harms 5%).*

http://www.conservationevidence.com/actions/640