Høgskolen
i Innlandet

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Evaluating effects from releasing hand-reared common pheasant (*Phasianus colchicus*) and grey partridge (*Perdix perdix*) on biological diversity and animal welfare in Norway

Vurdering av effekter på det biologiske mangfoldet, dyrevelferd og dyrehelse ved innførsel, oppdrett og utsetting av fasan og rapphøns i Norge

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Sammendrag

Institutt for Skog- og Utmarksfag ved Høgskolen i Innlandet fikk i oppdrag av Fuglehundklubbenes Forbund (FKF) og deres Lavlandskomite (LK) om å gjennomgå og vurdere praksisen med utsetting av fasaner og rapphøns, og spesielt evaluere økosystemeffekter, effekter på biodiversitet, dyrevelferd under oppdrett, avl, transport og utsetting, og risiko for dyrehelse og sykdommer ved import, avl, oppdrett og utsetting av disse fuglene i norsk natur.

Økosystemeffektene av å øke populasjoner kunstig kan være positive, negative eller ubetydelige fra et bevaringsperspektiv. Negative effekter inkluderer endringer i artenes samhandling via ressursforbruk, agonistisk adferd eller predasjon. Disse formene for interaksjoner mellom arter forsterkes med økende antall fugler satt ut. Under ekstreme forhold har utsetting av fasan hatt negative effekter på vegetasjonsdekke og virvelløse dyr inne i og på utsiden av akklimatiseringshegn i Storbritannia, og i Storbritannia opprettholder utsatt fugl sannsynligvis også høye bestander av generalistpredatorer.

Positive effekter av utsetting inkluderer støttende forvaltningstiltak som tar sikte på å begrense faktorer som reduserer overlevelse og populasjonsvekst som rovdyrkontroll, tilleggsfôring og habitatforbedring. Disse faktorene er forutsetninger for vellykkede utsettingsprogrammer, og de kan bedre bevaringsstatusen til flere andre arter. På grunn av lav overlevelse og uforløst reproduktivt potensial, antyder populasjonssimuleringer at utsatt rapphøns og fasan i Norge trenger støttende forvaltningstiltak for å unngå utdøing.

Målet når man avler rapphøns og fasaner er å selektere for vill adferd, og dette krever ulike oppdrettsforhold sammenlignet med domestiserte arter. Kunnskapsgrunnlaget om oppdrettsforhold som oppfyller behovene til fasaner og rapphøns er imidlertid lavt. Å øke plassen og berike habitatene i oppdrettssystemene vil imidlertid redusere stressrelatert adferd. Oppdrettsforholdene bør tilnærme seg naturlige forhold når det gjelder kosthold, uregulert sosialitet mellom individer og muligheten for eksponering for naturlige stressorer. Forskjellige patogener er registrert blant fasaner i Skandinavia, og import fra utlandet kan eksponere norsk hønsefugl for artsspesifikke sykdommer de vanligvis ikke ville påtruffet. Flere tiltak kan iverksettes for å minimere risikoen for spredning av patogener. Disse inkluderer hygiene på oppdrettsanlegg, veterinærundersøkelser av fuglene før import, og sikre oppdrettsanlegg som hindrer kontakt med dyreliv utenfor.

Når man vurderer utilsiktede effekter på økosystemer etter utsetting av oppdrettede fugler, er det viktig å ta hensyn til omfanget og skalaen på utsettingen. Studier som fokuserer fauna- og flora-effekter har hva vi kjenner til kun blitt utført i Storbritannia, der 47 millioner fasaner slippes ut årlig. Det norske utsettingsprogrammet er forsvinnende lite i forhold, og det finnes for øyeblikket ingen informasjon som støtter hypotesen om at rapphøns og fasaner som er satt ut i Norge de siste ti årene, har hatt negative effekter på norske økosystemer eller det biologiske mangfoldet. Med nåværende forståelse av dyrevelferd, er det også mulig å tilpasse oppdretts- og utsettingsprogrammer som minimerer risikoen for spredning av patogener og som produserer sunne og levedyktige individer som er godt tilpasset livet utenfor oppdrettsanlegget.

Emneord: Biodiversitet, dyrevelferd, fasan, oppdrett & utsetting, rapphøne

Oppdragsgiver: Fuglehundklubbenes Forbund v/Lavlandskomiteen

Abstract

The Department of Forestry and Wildlife Management at Inland University of Applied Sciences was commissioned by Fuglehundklubbenes Forbund (FKF) and their Lavlandskomite (LK) to scientifically review and assess the practice of releasing common pheasants (*Phasianus colchicus*, pheasant) and grey partridges (*Perdix perdix*, partridge), and specifically evaluate ecosystem effects, effects on biodiversity, animal welfare during rearing, breeding, transport and release, and animal health and disease risks when importing, breeding, rearing and releasing these birds into Norwegian nature.

Ecosystem effects of artificially augmenting populations may be positive, negative or negligible from a conservation standpoint. Negative effects include altering of species interactions via resource consumption, agonistic behaviour or predation. These forms of species interactions are amplified with increasing number of released birds. Under extreme circumstances, vegetation and invertebrate abundance have been negatively affected inside and around pheasant release pens in the UK and in the UK, released birds are also likely sustaining high populations of generalist predators.

Positive effects of releases include supporting management actions that target factors limiting survival and population growth like predator control, supplementary feeding and habitat improvement. These factors are prerequisites for successful release programs, and they can benefit the conservation status of several other species. Because of low survival and unrealized reproductive potential, population simulations suggest that partridge and pheasant releases in Norway need supporting management efforts to avoid population extinctions.

The goal when breeding partridges and pheasants is to select for wild behaviours and this require different rearing conditions compared to domesticated species. Yet, the knowledge base on rearing conditions that meet the need of pheasants and partridges is low. Increasing space and enriching habitats in rearing systems, however, will reduce stress-related behaviours. Rearing conditions should approximate natural conditions with regards to diet, unrestrained sociality between individuals and the possibility of exposure to natural stressors. Various pathogens have been recorded among pheasants in Scandinavia and imports from abroad can expose native galliformes to species-specific disease they would normally not encounter. Several measures can be adopted to minimize risks of spreading pathogens. They include hygiene at rearing farms, veterinary inspections of birds before import and secure pens that prevents contact with outside wildlife.

When assessing unintentional effects on ecosystems following the release of captive-bred birds, it is important to consider the scale and extent of the release. Studies focusing on impacts of releases on fauna and flora have to our knowledge only been conducted in the UK where 47 million pheasants are released on an annual basis. The Norwegian release program is dwarfed by comparison and there is currently no information that supports the hypothesis that partridges and pheasants released in Norway the last decade have had negative effects on Norwegian ecosystems or biodiversity. With our current understanding of animal welfare, it is possible to tailor rearing and release programs which minimize risk of the spreading of pathogens and that produce healthy and viable individuals that are well adapted to a life outside of the release pen.

Keywords: Animal welfare, biodiversity, captive-breeding & release, common pheasant, grey partridge

Financed by: Fuglehundklubbenes Forbund v/Lavlandskomiteen

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1 Background provided by FKF/Lavlandskomiteen

The Department of Forestry and Wildlife Management at Inland University of Applied Sciences was engaged by Fuglehundklubbenes Forbund (FKF) and their Lavlandskomite (LK) to scientifically review and assess the practice of releasing common pheasants (*Phasianus colchicus*, pheasant) and grey partridges (*Perdix perdix*, partridge), and specifically evaluate ecosystem effects, effects on biodiversity, animal welfare during rearing, breeding, transport and release, and animal health and disease risks when importing, breeding, rearing and releasing these birds into Norwegian nature. Simultaneously, we were asked to consider interventions, changes, and/or mitigations to decrease possible risks and negative effects on both animal welfare and biodiversity related to the practice of releasing pheasants and partridges after being bred in captivity.

The LK has released pheasants and partridges for pointing bird dog training for several years in Norway, and over the last 20 years, approximately 4-6000 birds have been released annually over a geographical area spanning from Trøndelag in the north, Rogaland in the west, and Østfold in the East. The released gamebirds either origins from Norwegian breeders and rearers, or they are imported from Sweden. Released birds are used during training and competition for pointing bird dogs, in contrast to other countries where released gamebirds are used as game for hunting purposes. Approval for release was denied for the first time in 2021, reasoned to negative effects on biodiversity and breaking the animal welfare act. In the end, approval was obtained to release gamebirds in 2021 by the Norwegian Ministry of Climate and Environment (KLD), although the Ministry stated the need for more knowledge and consequences related to the practice of releasing pheasants and partridges reared in captivity. In 2022 the practice of releasing gamebirds ended up in the Norwegian court system after animal welfare organizations reported the practice to the police, and it was once again denied releasing pheasants and partridges

The KLD and the Ministry of Agriculture and Food (LMD) recognized the knowledge gap related to ecosystem effects and animal welfare related to releasing captively bred pheasants and partridges and commissioned an evaluation of risks and negative consequences by the Norwegian Scientific Committee for Food and Environment (VKM). Simultaneously, the FKF wanted an objective scientific evaluation and engaged the Department of Forestry and Wildlife Management to make an evaluation of biodiversity, animal welfare and animal health importing, breeding, rearing, transport and moving, releasing and post release survival of pheasants and partridges, which resulted in this report. The following evaluation is divided into four main sections. First, the effect of Norwegian biodiversity by releasing pheasants and partridges are evaluated, specifically consequences for local ecosystems, vulnerable species, and possible cascading effects. Risk reducing efforts are identified, and additionally the risk for species with overlapping ecological niches are evaluated. Pheasants and partridge's survival in Norwegian ecosystems are modelled in a 50-year perspective. Animal welfare after release is the next section, and specifically pheasants and partridge's natural habitat and biotope is evaluated and identified in the Norwegian landscape. Natural mortality for wild pheasants and partridges are compared with captively bred pheasants and partridges, as far as possible based on available data. And mortality for similar Galliformes species in the Norwegian nature (willow ptarmigan, capercaillie, and black grouse) are compared. An assessment is also made to compare possible hardships captively bred pheasants and partridges can experience compared with wild born pheasants and partridges. Risk reducing effects to increase post release survival is evaluated. And lastly, the animal welfare effect of pointing bird dog training is assessed. Animal welfare during breeding and rearing is the third section, and farm systems, stocking densities, social structure, environmental enrichments, diet, and transport is evaluated. Measures to improve animal welfare is discussed in detail. Animal health is the last section. The probability for introduction of contagion by importing live bird to Norway is evaluated. The risk for spreading disease and contaminants when live birds or eggs are moved between different flocks is stated. The risk of spreading contagion to wild birds from captive bred bird, specifically when pheasants and partridges are released into the wild is evaluated. And lastly, risk reducing measures, including serological screening before releasing captive birds is assessed.

2 Introduction

Throughout history, humans have translocated, captive-bred and released fish and wildlife to augment existing or create new populations for food, sports or conservation. In Norway, humans populated empty lakes and bypassed natural barriers upstream rivers to augment or create new populations of trout (*Salmo trutta*) some 4000 years ago (Bjørkli et al. 2016). Even chamois (*Rupicapra rupicapra*) were released for hunting purposes in Hardangervidda during the 1860s (Andersen, Fagerheim, and Solheim 2009). Still today we are supplementary feeding garden birds and we provide nesting opportunities via nest boxes to species for our own pleasure and claimed benefits to avian communities despite the knowledge that such activities have the potential to alter the composition of species communities, change reproductive ecology, and affect species interactions (Fuller et al. 2008; Purcell, Verner, and Lewis W 1997; Sudyka et al. 2022).

In recent years, conservation of endangered species has been a prime motivator for management when species are bred and reared in captivity before release into the wild. In Norway, breeding programs, supplementary feeding and red fox (*Vulpes Vulpes*) control have been important measures in attempts at rebuilding populations of the endangered arctic fox (*Alopex lagopus*) (Landa et al. 2022). Norway has ratified the Bern Convention where the arctic fox is listed in Annex II (Council of Europe 1982) which suggest that the primary motivation behind artic fox conservation is international responsibility.

To prevent extinctions and to restore ecosystems, a private initiative of *ex-situ* captive-breeding and release of butterflies, namely the critically endangered *Scolitantides orion* and the near threatened *Parnassius Apollo* (Norwegian Biodiversity Center 2021), was recently approved by the Norwegian Environment Agency (Miljødirektoratet 2022a, 2022b) although both species are Least Concern on the European scale (IUCN 2022). Target areas of the release of *Parnassius Apollo* include Aust-Agder, a national park and other coastal areas in southern Norway, where the butterfly is extinct. The national park director hoped reintroduction of the Apollo butterfly would attract more visitors (Frank Johannessen 2023). Also, industries with substantial environmental impacts are often obliged, through licensing agreements, to mitigate their environmental footprint. As a concessionary of hydropower permits in rivers carrying anadromous salmonids, Statkraft was instructed to build and maintain a living gene bank containing fish from affected rivers. The purpose of this was to restock fish populations in order to promote fish, wildlife and recreation (Anon 2022b).

To restock or augment wild populations of partridge and pehasant for hunting, dog training or conservation purposes, captive rearing and release and has been a common measure in Western Europe (Rantanen et al. 2010a). The earliest releases of pheasants in Denmark and Sweden is reported to have occurred in the 1500s and 1740s respectively (Haftorn 1971) but perhaps as early as 1600s in Sweden (Rolf Brittas 2022). Nevertheless, influxes of pheasants from Sweden into Norway before 1800 have, to our knowledge, not been reported and is unlikely to have occurred, due to their poor dispersal abilities (Myrberget 1976).

In Norway, hand-rearing and restocking of pheasants and partridges have been practiced for at least 148 years (NJFF 1879). Collett (1894) describes introduction of partridge to the Stavanger area in the late 1800s. Sometime in the late 1800s a few individuals of partridge were imported from England and released around Stavanger and in 1882, 11 individuals (presumably from England) were released on Finnøy in Boknafjorden (Collett 1894). According to Haftorn (1971), partridge in Norway is believed to primarily stem from influxes from the Swedish population in the 1730s before it disappeared in the late 1700s for it to influx again in 1811. Widespread release practices throughout makes it difficult to assess the origin of partridges currently residing in Norway. The last known report of a nesting attempt by an endemic, wild partridge is from 1985 in Østfold (Ree 1989) which means that widespread claims of extinction in the 1940s are possibly wrong.

The body of relevant Norwegian literature for assessing the ecology and environmental impacts of released birds is non-existing but one study have summarized results from ringed pheasants (Myrberget 1976). Therefore, this report relies entirely on knowledge derived from agroecosystems abroad. This is a challenge because successful initiatives augmenting partridge and pheasant populations abroad include major management efforts, both with regards to the sheer number of released individuals, release methods, habitat improvement techniques and predator control on different scales compared to the activities undertaken in Norway the last decades. For instance, it is estimated that a total of 47 (39-57) million pheasants are released in the UK each year (Blackburn and Gaston 2021). A quote from Robertson et al. (2017) speak to this; *"The long history, wide distribution and intensity of pheasant releasing in the UK is probably unique as an example of artificially supplementing a naturally occurring terrestrial wildlife population".* Standard practice in the UK is to acclimatize pheasants in pens before they are released into the wild. These pens are relatively large, fenced-in areas with densities up to 1000 individual pheasants per hectare. The bulk of UK studies c.f. (Sage et al. 2020) confirming adverse effects of pheasants on the environment (e.g. ground flora and invertebrate fauna) have been conducted inside or around such pens. A British study estimating the total biomass of released gamebirds (of which the majority is pheasants) found that biomass of gamebirds at the peak numbers in august comprised about half of all bird biomass in the UK (Blackburn and Gaston 2021). Consequently, the environmental problem of pheasants in the UK is a problem of scale and numbers, rather than the species itself. The validity of such findings to the Norwegian agroecosystem and pheasant management is therefore poor.

Not only are the release practices widely different across Europe but also ecosystem composition and productivity vary greatly between the regions in which pheasants and partridges reside. This makes interpretations of species interactions (e.g. vital rates driven by predation or competition) difficult in the Norwegian context. For instance, UK has the highest densities of corvids and among the highest densities of red foxes in Europe (Roos et al. 2018).

The common pheasant is classified as an alien species in Norway because it has not been shown to reproduce in wild and viable populations before 1800. Its history in Norway appears identical to that of the mute swan (*Cygnus olor*) which escaped from captivity and the earliest record of wild mute swans is from 1869 (Bevanger 2005; Tømmerås, B. Å. et al. 2003) and is considered a Norwegian species and classified as least concern (LC) on the Norwegian red list (Norwegian Biodiversity Center 2021). Nevertheless, the pheasant is assessed by the Norwegian Biodiversity Information Centre as a low risk (LO) species due to minor invasive potential and minor ecological effect. The grey partridge is a Norwegian species with red list status as regionally extinct (RE).

Between 2013 and 2020, annual releases of partridges and pheasants into the Norwegian agroecosystem averaged 5638 individuals both species combined. Partridges are protected but pheasants can be hunted between October 1st and December 23rd. However, probably due to low popularity and few birds culled, the annual pheasant bag is not recorded by Statistics Norway.

The mandate given to us for this report is not to discuss the various motivations for captive breeding and release of such individuals into nature but to evaluate the ecological and animal welfare consequences of doing so. Below, we evaluate potential ecological impacts, prospects of population establishment and the animal welfare aspect concerning the captive breeding and release of pheasants and partridges in Norway within the context of the practices thus far.

3 Restocking effects on biodiversity and local ecosystem

3.1 Assessment of potential effects of restocking with captive-bred birds on biodiversity and local ecosystem

The main goal when artificially augmenting populations, including the release of captive-bred individuals, is to have an effect – or to impact the ecosystem by increasing the abundance of a target species. However, such activities may bring about unintentional effects as well. When assessing such unintentional impacts, it is critical to consider the scale and extent of the release (Madden and Sage 2020). Such impacts may be positive, negative or even negligible from a conservation standpoint. They may also be either directly or indirectly related to the act of releasing. The potential effects are therefore highly dependent on which species is being released, how many individuals that are released (density dependent) and the composition of the recipient ecosystem where the release is taking place. In general, predictions of such impacts are uncertain due to the complexity of ecosystem composition, unknown mechanisms linking ecological processes, and small inference-space from other ecosystems. Unfortunately, there is little knowledge to inform us on environmental impacts the release of captive-bred partridge and pheasant can potentially have on the Norwegian agroecosystem since no such studies have been conducted in Norway or similar habitats. The literature covering these topics however, points to various ecological concepts that can hypothetically be applied to Norwegian conditions.

One direct effect of releasing captive-bred individuals into areas where wild populations exist is genetic introgression and the loss of genetic diversity when captive-bred and wild-strained, native specimens "hybridize" and their offspring backcross into the population. This can dilute the genetic makeup of the "wild" part of the population (Andersen and Kahlert 2012) and introduce genes that are selected for during captive-breeding (e.g. genes related to tameness) (Bech et al. 2020). Genetic introgression can ultimately affect fitness. However, this is not always the case. In Finland, released partridge did not affect the genetic makeup of native partridge in areas they overlapped (Liukkonen 2006). In Norway, the partridge is listed as Regionally Extinct and it is therefore unlikely that strains from the "original" native partridge still exist intact.

Direct impacts can also be mediated through herbivory or predation. Local flora and fauna that are part of the species diet can be negatively affected as more released individuals consume more food. Negative impacts on local flora and fauna has been reported from UK release pens that holds extremely high densities of pheasants (Madden and Sage 2020). This is a good example of how the scale of the release activity cause problems for inference and external validity when assessing impacts of release on Norwegian agroecosystems.

Populations of predator species preying on the released individuals may exhibit a numerical response to the increase in prey availability (Pringle et al. 2019). Augmenting populations of one prey species may therefore also affect the linkages in one-predator/multiple-prey systems and thereby modulate indirect competition between two or more prey species for survival (i.e. apparent competition). Alternatively, as a response to a sudden population increase in the species being released, predators may also switch focus to rely predominantly on released individuals and thus alleviating predation pressure on other prey. Finally, competition over shared resources (i.e. exploitation competition) can have negative impacts on other species whose niche (e.g. diet, nesting habitat) overlaps with that of the released species.

Concerns have been raised in the public discourse that predation by released pheasants (and partridge) will negatively affect local populations of herptiles like salamanders, frogs and snakes. Anecdotal evidence and a photograph of a pheasant eating a juvenile grass snake (*Natrix natrix*) have fuelled the discussion. An extensive review on ecological effects of released gamebirds in England report on five dietary studies investigating diets from > 2500 individual pheasants in the UK and US. No study reported vertebrate prey remains. Similarly, DNA-techniques failed to identify herptiles in a sixth study (Madden and Sage 2020). Associations between high densities of pheasants (e.g. around release sites in the UK) and lowered abundance of reptiles is therefore unlikely to be caused by predation.

The restocking of gamebird populations throughout Europe is in many areas reinforced with management schemes aiming to reduce limiting factors impacting gamebird populations. These schemes include habitat improvement, legal predator control and supplying food among other techniques. A review, of mostly UK-studies, found that habitat improvement in agricultural habitats and legal predator control had positive effects on non-target species in 85 and 96% of the cases respectively (Mustin et al. 2018). The study also points out however, that illegal predator control in relation to released gamebirds can impede conservation efforts. Improvement of agricultural habitats can include reduced use of pesticides, set-aside patches of wasteland, growing of crops that improve cover and food, or floristically enhancing of habitat edges. The grey partridge has been referred to as the countryside barometer (G. R. Potts 2012) due to its affinity to a healthy agroecosystem. Healthy in this regard, points to a heterogenous composition of the agro-landscape with hedgerows, wastelands, floristically enhanced patches or strips and little use of pesticides. In Sweden for instance, habitat management for partridges and pheasants was associated with increased numbers of pollinators in the wider landscape (Jönsson et al. 2015) and in fact, a EU interreg research program now focuses on the benefits to the ecosystem of managing farmland habitats for partridge (Interreg North Sea Region 2023).

- Releasing captive-bred individuals can affect the genetic diversity in native strains where they exist. This does not apply to Norwegian conditions since partridges are regionally extinct and pheasants originate from releases.
- Augmenting populations through releases can affect the relationship between species within an ecosystem through interspecific and intraspecific competition or numerical and functional responses in predators. The low number of released birds in Norway suggest that this is has not been an issue and will not be an issue if practices continue on the same scale in the future.
- Management efforts supporting release programs, like habitat improvement and legal predator control, is a prerequisite for establishing self-sustaining populations and can benefit other species with conservation concerns.

3.2 Consequences of restocking and cascading effects on the ecosystem

Captive-bred and released partridge are naïve and especially prone to predation because their activity budgets are not adjusted to the presence of predators (Rantanen et al. 2010b). Supplementary feeding and predator control can improve survival of released birds, but it requires substantial efforts and resources. Legal predator control involves controlling populations of generalist predators such as red foxes and corvid species. Such efforts can also improve conservation status of other bird species inhabiting the agricultural landscape (Stoate and Szczur 2001). Supplementary feeding of partridge and pheasant during winter may have positive effects on other granivorous birds. A study from Finland showed that yellowhammer (*Emberiza citrinella*) was a frequent visitor to feeding sites meant for black grouse (*Lyrurus tetrix*) (Marjakangas 1986). Supplementary feeding, however, does not discriminate between the species it attracts and may also attract and sustain species that are unwanted from a conservation standpoint (Sánchez-García, Buner, and Aebischer 2015) like wild boar (*Sus scrofa*). Nonetheless, the extent to which supplementary feeding of released pheasants and partridges differ in ecological effects from those of e.g. garden bird feeding in the same landscape remains unclear (Reynolds et al. 2017).

Successful release programs often entail habitat improvement schemes that are long lasting and have positive effects on other bird species and insect pollinators in the agricultural landscape. Habitat improvements include set-aside patches of natural weeds, which provide high insect availability (e.g. beetle banks) and excellent cover for ground nesting species (Šálek et al. 2004). Cover strips with hedgerows tend to increase winter survival (Bro et al. 2004) and reinforcing wild-flowers by sowing will further increase invertebrate abundance and hence chick survival (Buner et al. 2005). The partridge in particular, is a good indicator species of the quality and functioning of agroecosystems (Buner et al. 2005) and it is one of many species that are highly sensitive to changes in agricultural practices that typically have reduced cover and food availability but increased generalist predators as red fox and corvids. The partridge can be viewed as an umbrella species, and management that successfully support a partridge population will also support other red listed species in landscapes dominated by agricultural land use. Charismatic avian species residing inside or in relation to the agricultural landscape and red listed in Norway include but are not limited to northern lapwing (*Vanellus vanellus*) CR, Eurasian curlew (*Numenius arquata*) EN, common quail (*Coturnix coturnix*), yellowhammer (*Emberiza citrinella*) and corncrake (*Crex crex*) CR. Habitat improvement and increased biodiversity will result in positive effects to ecosystem goods and services provided by farmland in general.

- Managers aiming at establishing self-sustaining populations of partridges and pheasants need to support release programs with control of generalist predators, supplementary feeding and habitat improvement to succeed. Such efforts are resource consuming and require cooperation between landowners.
- Supplementary feeding may attract and sustain species that are unwanted from a conservation standpoint but will also benefit a range of other species.
- Legal control of generalist predators in relation to captive-breeding and releasing will benefit a range of species in the agricultural landscape that are of conservation concern.
- Habitat improvement will benefit several species across different taxa that are of conservation concern.

3.3 Prospects of grey partridge and common pheasant future survival and establishment in Norwegian nature

Observations of both pheasants (Figure 2) and partridges (Figure 3) have been reported in the period between March and June every year between 2000 and 2021. Several reports have also been made of brood rearing females of both species in July (Norwegian Biodiversity Information Center). Pheasants seem to have established in local populations in the Oslo Fjord area, around lake Mjøsa in Innlandet County and on Jæren in Rogaland County (Anon 2018). These areas also hold partridge populations, but it is unclear if they are surviving without supplementing with individuals through release programs or other management efforts.

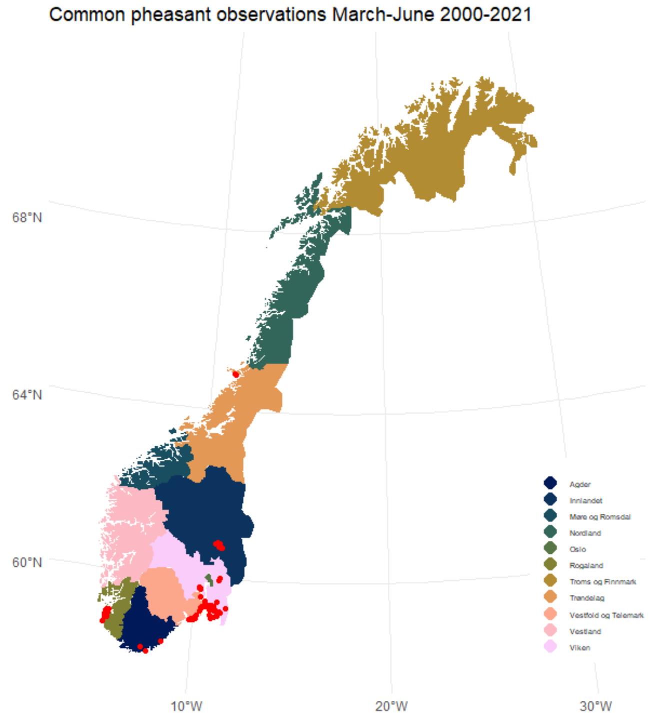

Figure 1 Observations of Common pheasant (red dots) reported to The Norwegian Biodiversity Information Centre (Artsdatabanken) from March throughout June in the years 2000-2021.

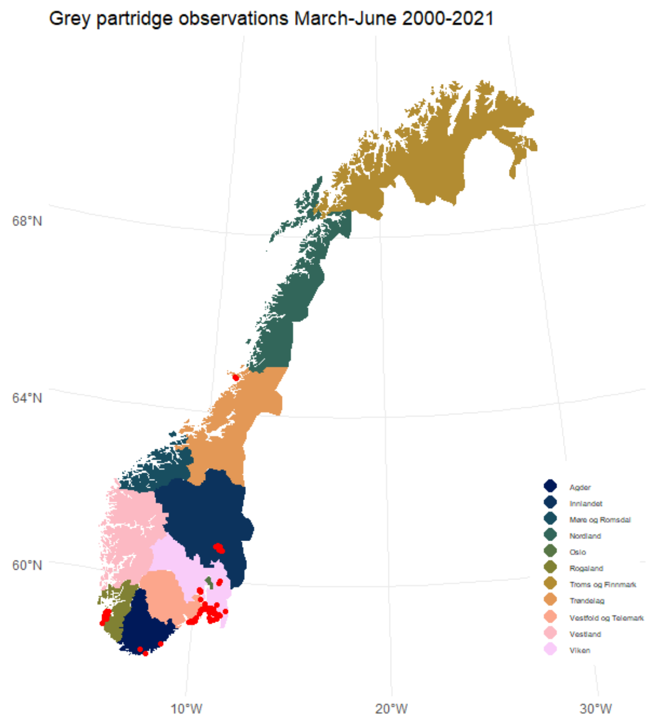

Figure 2 Observations of Grey partridge (red dots) reported to The Norwegian Biodiversity Information Centre (Artsdatabanken) from March throughout June in the years 2000-2021.

Partridges and pheasants tolerate low temperatures, but cold weather may affect their metabolism. For partridges, food consumption increase two-fold between +15°C and ÷15°C (G. R. Potts 2012). Snow conditions need to allow for searching food under the snow as increasing snow depths are associated with higher mortality in e.g. pheasants (Kauth et al. 2022). Therefore, severe winter climate can affect both species negatively if food is not available. In Finland and Russia, partridge occurs northwards, approaching the arctic circle. The Tornedalen area in northernmost Sweden was known for abundant partridge populations before agriculture became mechanized after WWII. Parts of coastal areas in Norway, with mild winters, and areas inland with continental climate and little snowfall, are therefore suitable to partridges and pheasants with regards to climate. However, predictions of range expansions based on climate alone, at least for partridge, is difficult because of the importance of other factors like habitat quality, especially food availability which is modulated by farming practices (G. R. Potts 2012).

Successful reintroductions of partridge or population augmentation schemes aimed at hunting or conservation across Europe for both pheasants and partridges require legal predator control and habitat improvement increasing biodiversity. Since 2019, the National Pollinator Strategy, managed by County Governors is an initiative where farmers get compensated to sow perennial flower strips along field margins to improve habitats for pollinators. Such habitat improvement schemes provide good cover for partridge and pheasant, and especially insect availability the first weeks after hatching for chicks (Buner et al. 2005; Nelli, Meriggi, and Vidus-Rosin 2012). It should be noted that small populations always run the risk of going extinct because of stochastic factors affecting smaller populations to a much larger degree than large populations. One consequence is that a small population can go extinct within a few years even though it would be expected that environmental conditions would easily sustain a large population.

Below we simulate various population scenarios of both species based on survival and reproduction estimates obtained from wild and released birds.

3.4 Estimates of survival and reproduction of wild and released pheasants and partridges

3.4.1 Estimating population development

Combinations of survival and fecundity have been used to estimate population growth for a long time. The combination of these values results in an expected deterministic growth rate. However, nature is not constant and demographic rates vary between years, higher variation tends to increase the risk of extinction. We used the *popbio*-package available in R-Cran to estimate both the deterministic and stochastic growth rates, population size after 5 years and an estimate of the risk of extinction (< 10 females) starting with a local population of 100 females.

3.4.1.1 All models are wrong, but some are useful

The central part of the information is a population matrix where *s* is survival of different age-classes and *f* is the number of chicks per pair in august (Table 1). It is difficult to find estimates of these demographic rates, and we begin with defining a "wild" population expected to stay stable in a deterministic system. Time has not allowed to do an extensive review of the literature and evaluate the conditions of the different populations. Also, survival may only be available for part of the year and we have extrapolated the reported values to reflect what the annual survival would be. The values used in our simulations are rough estimates and henceforth also our simulations.

Table 1 Symbolic population matrix of a post-breeding population. f is average brood per pair and s is annual survival.

	Young	Ad1	Ad2+
Young	$f1 * s1$	$f1 * s1$	$f1 * s1$
Ad1	s1	-	-
Ad2+	-	s2	s3

3.4.2 Grey partridge

3.4.2.1 Survival and fecundity of "wild" partridge

The survival rate through spring and summer ranged from 0.25 to 0.65 (Bro et al. 2001). Mortality mainly occurred in May, June and July. Females may suffer from high mortality rates (as high as 60%) during breeding as previously reported by (Birkan et al. 1990, 1992) and Reitz (1992) in cereal ecosystems in the "Bassin Parisien" and "Centre" regions in France. Predation appeared as a major cause of death for healthy partridge during breeding. Six month annual female survival is therefore scaled to a full year, 12 months: $0.65^2 = 0.422$. Based on the 1990–2000 Sussex data, mean (± SE) demographic parameters for partridge were 0.619 ± 0.035, 0.703 ± 0.014, 0.294 ± 0.020 and 0.593 ± 0.042 for survival rates of nests, breeding females, chicks and overwintering females, respectively (Aebischer and Ewald 2004). Assuming an average of 14 eggs hatching per clutch (Potts 1986), these values gave an annual rate of population change of 0.929, which was very close to the value of 0.926 estimated from British Trust for Ornithology/Common Breeding bird Census data for the partridge over the same period.

Sotherton et al. (1993) found that, over 8 years, chick survival rate averaged 0.23 on fully sprayed areas and 0.39 in selectively sprayed areas. From these British studies we estimate an annual female survival to be: 0.703*0.593=0.417.

From six weeks onwards, the survival rate of young partridges is effectively the same as that of adults (Potts 1986). These studies also reported a mean number of chicks per pair to be = 3.07.

3.4.2.2 Survival and fecundity of released partridge

Of released birds, survival tended to be highest in fostered chicks (0.86 ± 0.03; $0.86^6 = 0.40$) and translocated adult wild birds (0.82 ± 0.06; $0.82^6 = 0.30$). While survival of these groups was not statistically different from each other, survival of captive-reared adults was significantly lower (0.70 ± 0.06; $0.70^6 = 0.12$) (Buner and Schaub 2008). These values correspond to two-months and must be raised by a factor of 6 to obtain approximately annual survival values. These values are probably underestimating survival because the two-month period supposedly was the part of the year of highest predation but nonetheless indicate the sensitivity of released partridges from captive breeding.

3.4.2.3 Population model partridge

We can use survival rates and number of chicks per female to evaluate reasonable values that would stabilize a partridge population. Below is a matrix projection assuming that we estimate population status in beginning of August. Here we have assumed that females have on the averaged managed to produce 1.5 female chick/female each, with no difference in fecundity between one year old and older females. We assume that the survival of first year breeders is 0.36 and that of older females is 0.46. The deterministic population matrix then becomes (Table 2):

Table 2 Initial demographic rates of a simulated wild partridge population that neither increase nor decrease.

	Young	Ad1	Ad2+
Young	0.54	0.69	0.69
Ad1	0.36	0.00	0.00
Ad2+	0.00	0.46	0.46

These values give a population that will neither decrease nor increase (lambda = 1.00) with a stable age-distribution of 0.60 young, 0.22 Ad1 and 0.18 Ad2+. The sum of elasticities (i.e. relative contribution of each parameter to growth rate) of fecundity is 0.46 and of survival is 0.54 which mean that 1 % increase in fecundity will increase growth rate with 0.46 % and 1 % increase in survival will increase growth rate 0.54 %. Thus, variation in both fecundity and survival will affect population development equally. However, we also add variation to the demographic parameters because it will reduce expected population growth. The standard errors of the survival are set to 0.05 and that of fecundity is set to 0.15 throughout all simulations. The estimated stochastic growth is then reduced to 0.988. The simulated distribution of survival and "fecundity" rates is shown in figure 3 and 4. The simulated population size after 5 years is shown in figure 5 and the risk of extinction is shown in figure 6.

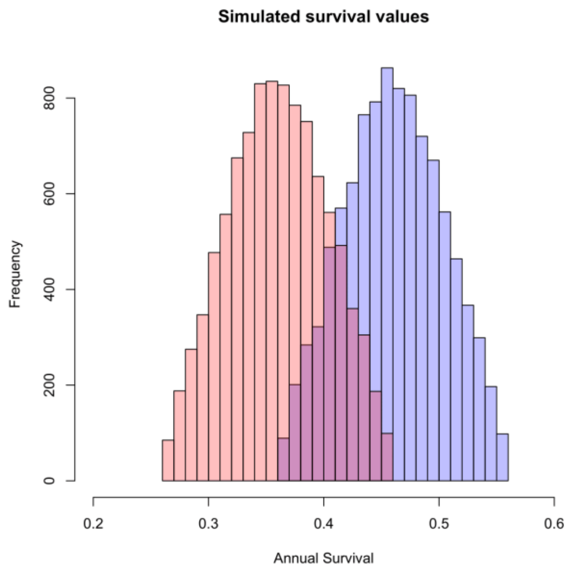

Figure 3 The distribution of simulated annual survival (August - August) for yearling (orange) and older females (blue).

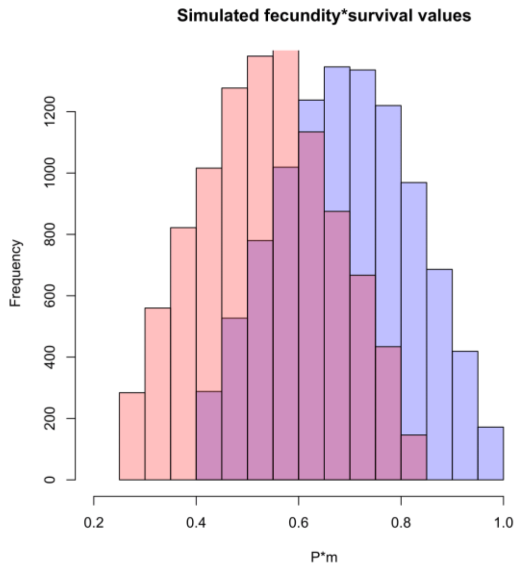

Figure 4 The distribution of simulated number of chicks per female for yearling (orange) and older females (blue). Values depend on fecundity and subsequent survival.

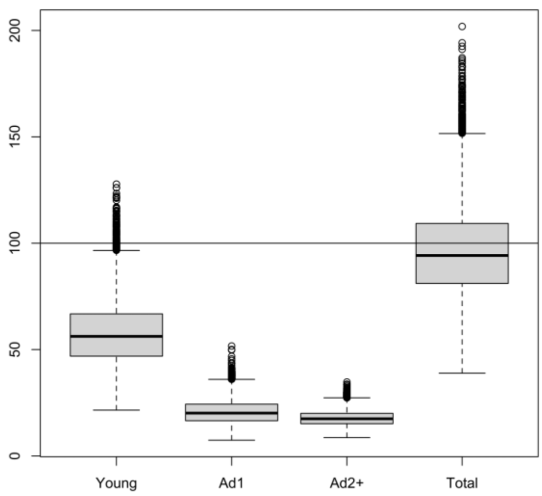

Figure 5 The estimated numbers of partridge in the August population after 5 years after starting with 100 females. Total population and different age classes are presented, and the horizontal line shows the starting population

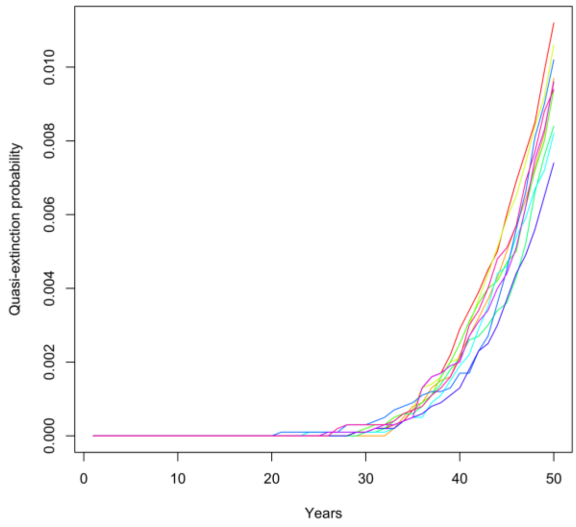

Figure 6 The risk of extinction for the wild demographic parameters in table 2. Note the low values on the y-axis.

3.4.2.4 Reduced demographic rates - captive breeding and survival

Here we assume that all demographic parameters are reduced to 80% of the previous survival and fecundity rates (Table 3).

Table 3 Matrix of reduced demographic rates.

	Young	Ad1	Ad2+
Young	0.3456	0.4416	0.4416
Ad1	0.2880	0.0000	0.0000
Ad2+	0.0000	0.3680	0.3680

The estimated stochastic growth is now reduced to 0.747. The simulated distribution of survival and “fecundity” is shown in figures 7 and 8. The simulated population size after 5 years is shown in figure 9 and the risk of extinction is shown in figure 10.

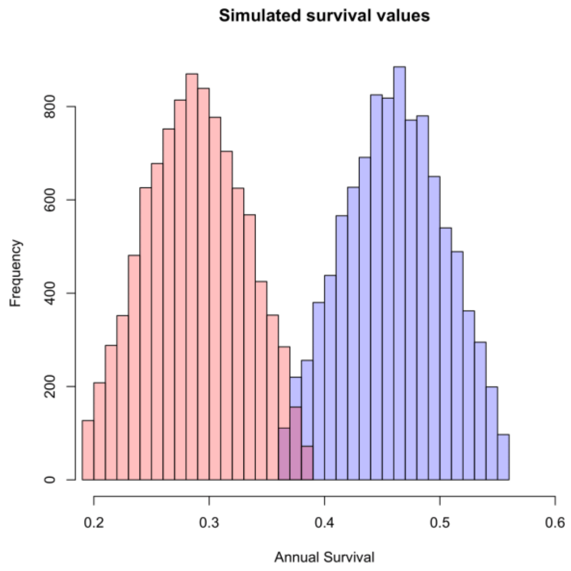

Figure 7 The distribution of simulated annual reduced survival (August-August) for yearling (orange) and older females (blue).

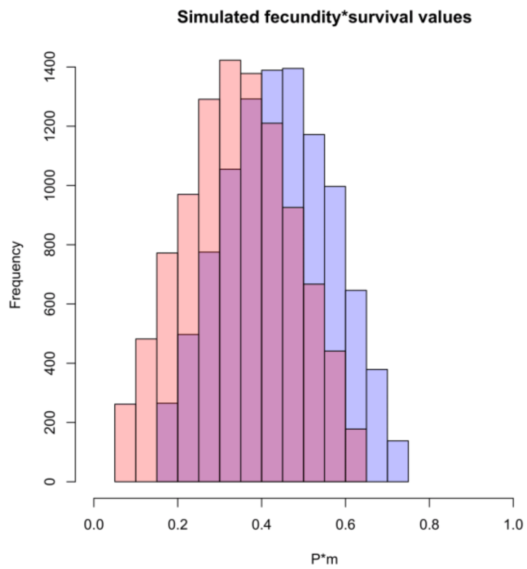

Figure 8 The distribution of simulated number of reduced chicks per female for yearling (orange) and older females (blue). Values depend on fecundity and subsequent survival.

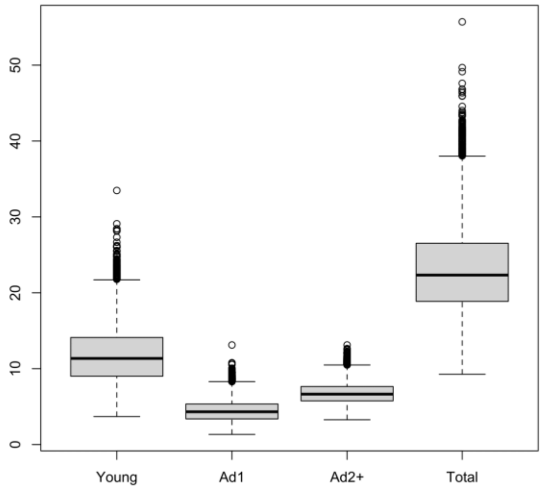

Figure 9 The estimated numbers of released partridge in the August population after five years. The starting population was 100 females.

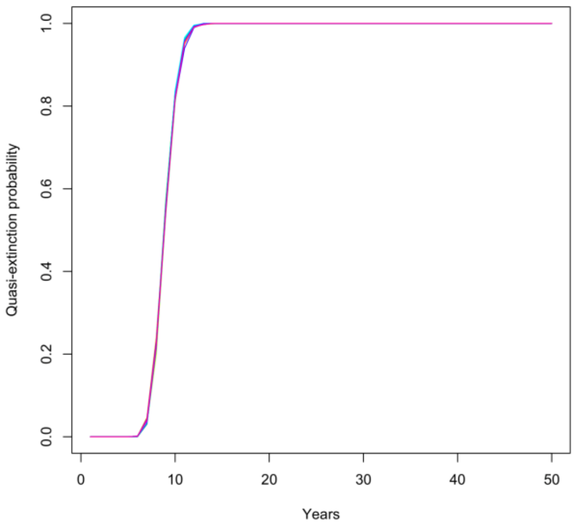

Figure 10 The risk of extinction for the released partridge. Demographic parameters in table 3.

3.4.2.5 Reduced survival rates increased chick survival - captive breeding

Changing methods in captive breeding and release of captive birds together with predator control can increase brood size in August but less effect on over-winter survival.

Increasing overall brood size from 3 to 4 in August but keeping survival the same as above give a population matrix as shown in table 4.

Table 4 Matrix of increased chick production and low survival.

	Young	Ad1	Ad2+
Young	0.4608	0.5888	0.5888
Ad1	0.2880	0.0000	0.0000
Ad2+	0.0000	0.3680	0.3680

The distribution of survival values is the same as in figure 7 and the new fecundity values are shown in figure 11.

The estimated stochastic growth is now increased to 0.823 but is still substantially below the simulated distribution of survival and "fecundity" is shown in figure 7 and 8. The simulated population size after 50 years is shown in figure 12 and the risk of extinction is shown in figure 13.

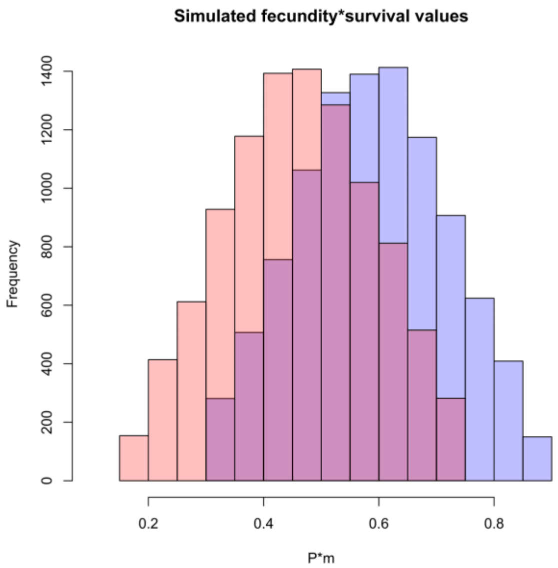

Figure 11 The distribution of simulated number of increased chicks per female for yearling (orange) and older females (blue). Values depend on fecundity and subsequent survival.

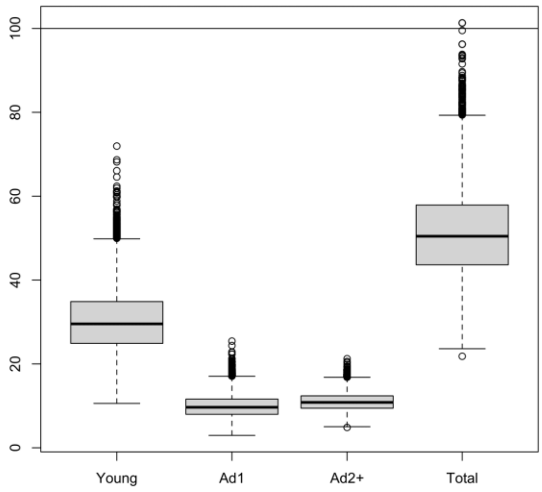

Figure 12 The estimated numbers of released partridge in the August population after five years in the third simulation (low survival and increased brood size)

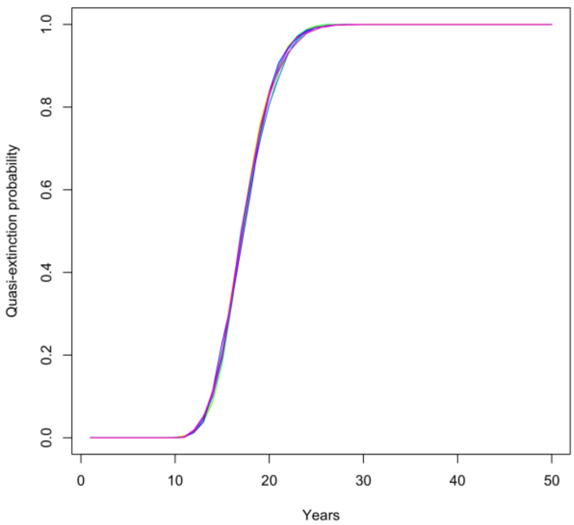

Figure 13 The risk of extinction of released for the demographic parameters in table 3.

3.4.3 Common pheasants

3.4.3.1 “Wild”

Like the estimated demographic rates of partridge we use values from literature that were scaled up to annual estimates. Wild pheasant annual survival in Sweden was 0.45 (Brittas et al. 1992). Wild pheasant annual survival in North Dakota, USA, was 0.30 (Leif 1994) whereas later studies found a survival of 0.28 (Schmitz and Clark 1999) and 0.29 (Kauth et al. 2022). Late summer brood sizes have been reported to 4.4 (Warner et al. 1984) and 3.3 (Hill 1985). Studies of wild population of pheasants indicate that annual survival of adult pheasants is somewhat higher than for wild partridges, on the other hand the average brood size in August is somewhat lower. Here we have assumed that females have on average managed to produce 2 female chick/female each with no difference between one year old and older females. We assume that the survival of first year breeders is 0.32 and that of older females is 0.36. The deterministic population matrix is shown in table 5.

Table 5 Initial demographic rates of a simulated wild pheasant population that neither increase nor decrease.

	Young	Ad1	Ad2+
Young	0.64	0.72	0.72
Ad1	0.32	0.00	0.00
Ad2+	0.00	0.36	0.36

These values give a population at equilibrium that neither decrease nor increase (lambda = 1.00) with a stable age-distribution of 0.67 young, 0.21 Ad1 and 0.12 Ad2+. The sum of elasticities of fecundity is 0.64 and of survival is 0.36. Thus, variation in both fecundity and survival will affect population development equally.

The estimated stochastic growth is λ=0.986. The simulated distribution of survival and “fecundity” is shown in figure 14 and 15. The simulated population size after 5 years is shown in figure 16 and the risk of extinction is shown in figure 17.

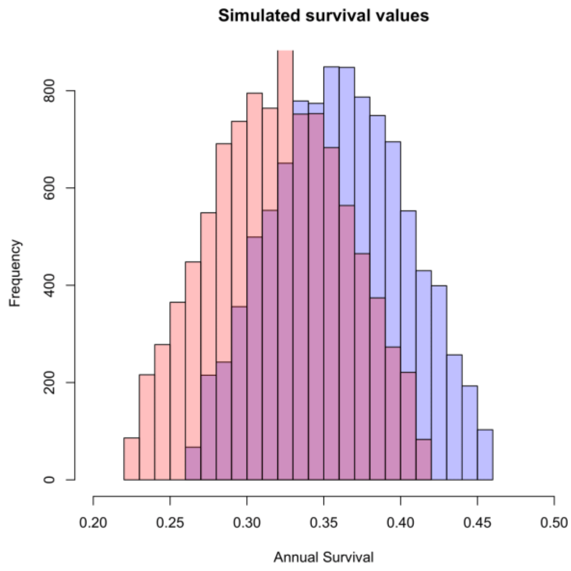

Figure 14 The distribution of simulated annual survival (August-August) for yearling (orange) and older females (blue) of pheasants.

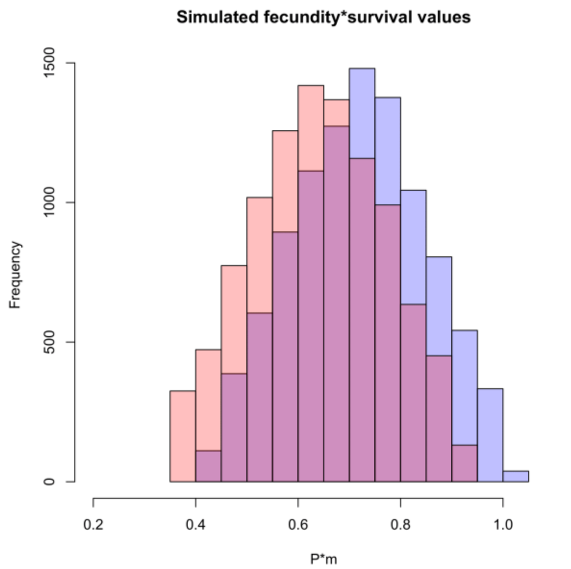

Figure 15 The distribution of simulated number of chicks per female for yearling (orange) and older females (blue) pheasants. Values depend on fecundity and subsequent survival.

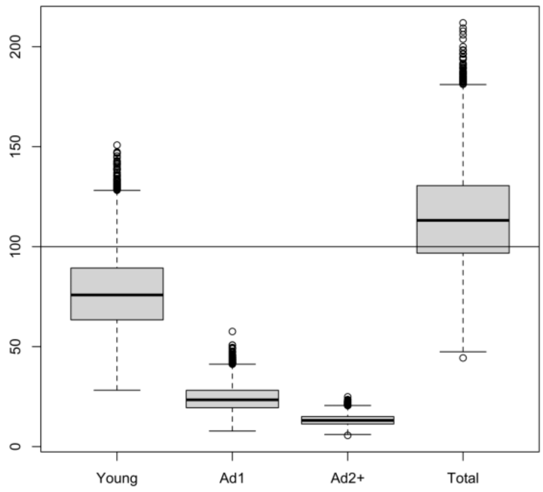

Figure 16 The estimated number of female pheasants in the August population after five years. Total population and different age classes are presented, and the horizontal line shows the starting population.

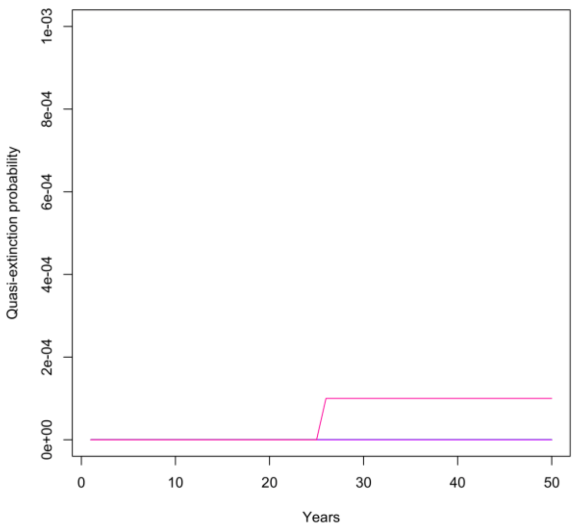

Figure 17 The risk of extinction for the wild pheasant demographic parameters in table 5.

3.4.3.2 Reduced demographic rates – captive breeding and survival

As for partridges, released pheasants from captive breeding show substantially lower survival. Survival on Gotland was 0.16 (Brittas et al. 1992) and as low as a few percent in Dakota (Leif 1994). Like the partridge simulations, we assume that all demographic parameters are reduced to 80% of the previous survival and fecundity rates (Table 6).

Table 6 Matrix of reduced demographic rates.

	Young	Ad1	Ad2+
Young	0.410	0.460	0.460
Ad1	0.256	0.000	0.000
Ad2+	0.000	0.288	0.288

The estimated stochastic growth is as low as 0.698. The simulated distribution of survival and "fecundity" is shown in figure 18 and 19. The simulated population size after 5 years is shown in figure 20 and the risk of extinction is shown in figure 21.

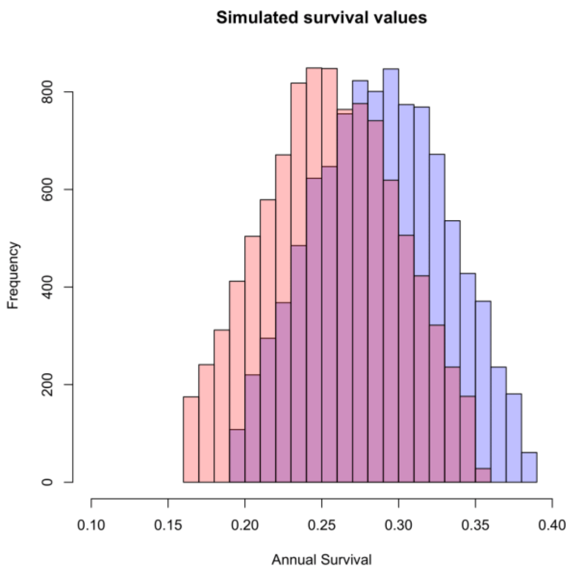

Figure 18 The distribution of simulated annual reduced survival (August-August) for yearling (orange) and older females (blue) pheasants.

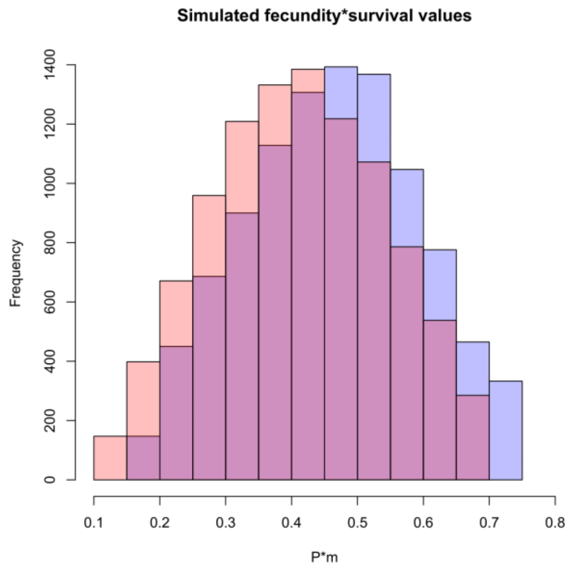

Figure 19 The distribution of simulated number of reduced chicks per female for yearling (orange) and older females (blue) pheasants. Values depend on fecundity and subsequent survival.

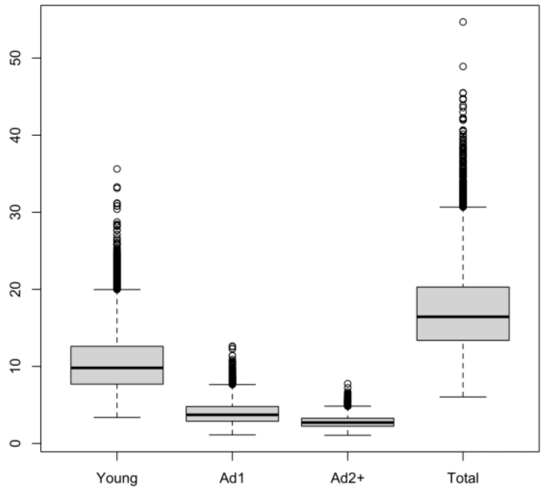

Figure 20 The estimated numbers of female pheasants in the August population after five years from 100 released.

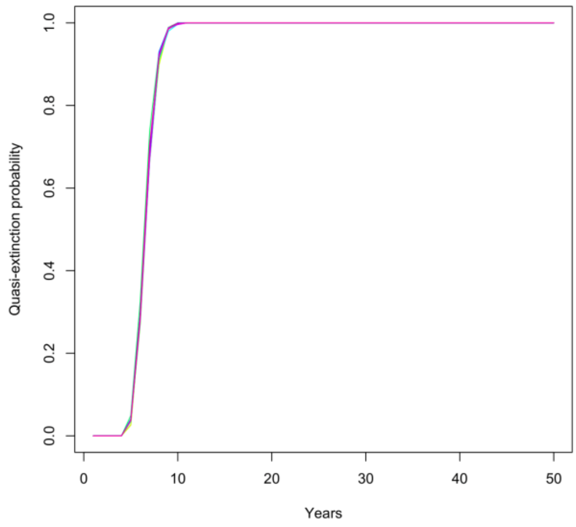

Figure 21 The risk of extinction of released for the demographic parameters in table 6.

3.4.3.3 Reduced survival rates increased chick survival - captive breeding

Substantially increasing overall brood size to 5 in August but keeping the survival the same as above give a population matrix as shown in table 7.

Table 7 Matrix of increased chick production and low survival.

	Young	Ad1	Ad2+
Young	0.640	0.720	0.720.
Ad1	0.256	0.000	0.000
Ad2+	0.0000	0.288	0.288

The distribution of survival values is the same as in figure 7 and the new fecundity values are shown in figure 11.

The estimated stochastic growth is λ=0.930. The simulated distribution of survival and “fecundity” is shown in figure 18 and 22. The simulated population size after 5 years is shown in figure 23 and the risk of extinction is shown in figure 24.

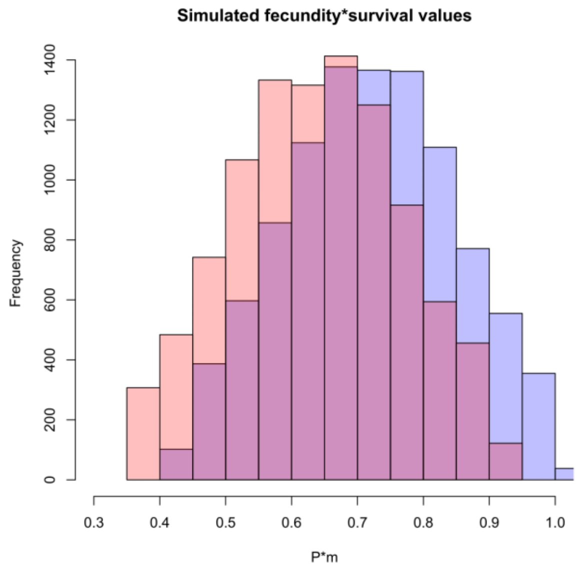

Figure 22 The distribution of simulated number of increased chicks per female for yearling (orange) and older females (blue). Values depend on fecundity and subsequent survival.

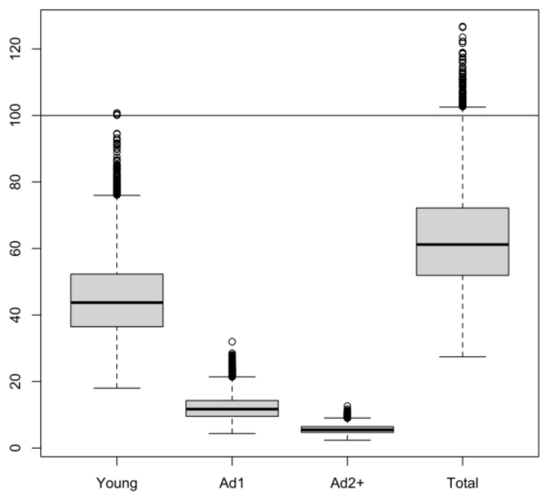

Figure 23 The estimated numbers of released pheasants in the August population after five years in the third simulation (low survival and increased brood size).

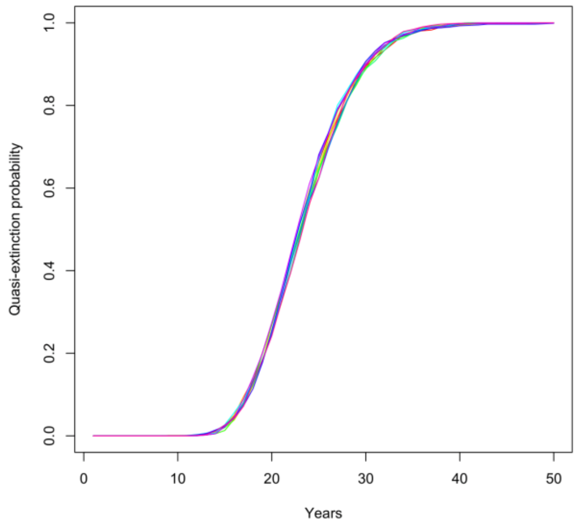

Figure 24 The risk of extinction of released for the demographic parameters in table 7.

- Simple population models are useful for modelling population growth based on survival and fecundity rates collected in the field.
- Extinction risks for both partridges and pheasants indicate that populations of released birds will go extinct without substantial management efforts improving demographic parameters.
- Elasticities indicate that fecundity and survival equally contribute to the growth rate of pheasant and partridge populations. Management actions aimed at establishing self-sustaining populations therefore need to improve both survival and fecundity in partridges and pheasants.

3.5 Identification and evaluation of potential risk reducing measures

We consider the environmental impacts of released pheasants and partridges on Norwegian agroecosystems to be negligible due to the small scale of releases. Should upscaled release practices continue in the future and hence the number of birds released substantially increase, effects of competition between partridge/pheasant and other species should be investigated. The threshold for competition, however, can be manipulated via habitat improvement schemes. Schemes like the pollinator initiative from the Environmental Agency can reduce negative impacts of species interactions by providing more habitat of higher quality. Habitat improvement schemes, however, are not straight forward. A French study investigated habitat improvement (i.e. planting legumes and cereals) to provide cover for partridge to avoid predation during winter. This measure worked against its purpose. The creation of new, improved habitat entailed unintended and unexpected effects because partridge mortality aggravated in and around these cover strips. The authors suggested that a disproportionate concentration of birds in seemingly attractive, newly created habitat (i.e. cover strips) functioned as an ecological trap because predators could more easily search and find them (Bro et al., 2004).

Legal predator control is an important tool if the goal is to succeed with establishing self-sustaining pheasant and partridge populations. Especially the red fox is an important predator on eggs, chicks and adults and red fox populations must be kept low to relieve partridges and pheasants of predation. For most studies reporting successful establishment of the two species, techniques always include predator management. Predator control will also be beneficial to other ground nesting bird species in the agricultural landscape.

- Environmental impacts of released captive-bred partridges and pheasants into Norwegian ecosystems are most likely negligible due to low numbers and small-scale activity.
- The success of releasing pheasants and partridges is determined in part by the number of predators in the landscape. Legal control of generalist predators is a prerequisite for success.

3.6 Niche overlap and competition with Norwegian species

Forty-five million individual birds of 255 species are estimated to nest in Norway annually, of which approximately 40 species nest inside or in relation to agroecosystems (Christian Pedersen 2020; Shimmings and Øien 2015). Interactions between these species, such as competition occur between individuals belonging to different species (interspecific) and among individuals belonging to the same species (intraspecific). Competition is a major driver of trophic interactions and subsequently it can therefore alter ecosystem composition (Robert MacArthur and Richard Levins 1964) or determine ecological niches (Diamond 1978).

Competition between species takes on three main forms. Species can interact directly by fighting over shared, limited resources such as food or habitat (interference competition). Species can compete indirectly, by one species depleting limited resources shared with other species (exploitation competition) or two species can indirectly compete for survival through a shared predator (apparent competition).

Partridge and pheasant chicks rely heavily on protein rich foods post fledging. For partridge, the number of insects found in crops is the highest around the age of 20 days and insects disappear completely after 50-60 days (G. R. Potts 2012). This means that when birds are released into fields in late summer/early autumn, their diets are predominantly granivorous (seed-eating) and graminivorous (grass-eating) although adult pheasants will occasionally eat insects during summer (Hill and Robertson 1988b). The potential for competing over food with other insectivorous species is therefore only realized when released birds survive winter and successfully reproduce the next spring. Under current conditions, competition between partridge, pheasants and other species over insectivorous foods is therefore minimal.

Both partridges and pheasants exhibit territorial behaviour during spring (e.g. by crowing) and partridge pairs also defend the part of the territory that is restricted to the immediate area surrounding the individual (Blank and Ash. 1956). Such behaviour is primarily aimed at conspecifics but may also include members of other species that are phylogenetically similar like red legged partridge (*Alectoris rufa*) (Rinaud et al. 2020). In the UK, proximity to pheasant pens had no relationship with partridge density, fecundity or survival (Ewald and Touyéras 2002). Territorial behaviour can nevertheless physically displace conspecifics or similar species, affect their singing schedule or constrain the ranges of the subordinate species (Brumm 2006; Jankowski, Robinson, and Levey 2010; Rinaud et al. 2020). Accounting for the number of released individuals, we doubt if releasing partridges and pheasants thus far has had a measurable/practical impact on potential competitor species in Norway.

In areas where similar species coexist, hybridization between species may occur. *Phasanius* X *Lyrurus* and *Phasanius* X *Tetrao* hybrids are rare but have been reported from the UK (Peterle 1951). Hybridization between birds occur most frequently during range expansions or in areas where one of the two species is rare. It is unclear if these hybrids can backcross into wild strains but various *Alectoris* (*chukar* and *rufa* (including subspecies)) X *Perdix* hybrids and subsequent offspring were reported to disappear after few generations (Potts 1996).

- Interactions between different species or between individuals of the same species takes on different forms.
- Individuals can via agonistic behaviour compete for shared, but limited resources. Species can depress one another by depleting a shared, limited resource or species can compete for survival through a shared predator.
- When partridges and pheasants are released, they are predominantly granivorous and graminivorous. There is a potential for competition over food with resident species sharing their diet through autumn and winter

- The potential for competition between release partridge and pheasants is probably not realized due to small numbers of pheasants and partridges.

4 Animal welfare when releasing birds

4.1 Pheasant and partridge natural habitat and presence of such habitats in Norway

The grey partridge is native to arable lands and steppe of the temperate zone in Europe and central-Asia, ranging from the British Isles in the west to Kirgizstan in the east. Northwards the distribution reach the southern parts of Scandinavia, although in Finland and Russia partridge are found as far north as the arctic circle. The most southern part of the range includes Iran in the southeast and Portugal in the southwest. It prefers mixed but open habitats, low-intensity farmlands with set-aside patches of wasteland, hedgerows and shrubby areas. The species originally inhabited steppe landscapes but took advantage of semi-natural manmade agricultural lands. The species have been introduced to North America for hunting.

The common pheasant is native to Asia, east of the Black Sea and from the Caucasus Mountains eastwards to China. Peasants have been introduced in many parts of the world for hunting purposes. In Europe, its distribution largely overlaps that of partridge, but pheasants prefer the edge between agricultural land and woodland. Arable land interspersed with woodlands, thickets or conifer plantations with dense understory vegetation is pheasant habitat.

Norway has always been on the edge of the distribution for partridges and pheasants and in Norway the species distributions within suitable semi-natural habitats are mainly restricted by snow depth. Low temperatures are generally not a problem if the birds can access food under the snow. Historically, partridge was found in areas with continental climate such as Gudbrandsdalen and Østerdalen as far north as Tynset and in milder climate around lake Mjøsa, southwards around the Oslo Fjord and along the coast to Rogaland. Partridge was also released around Trondheim. Pheasants are remarkably sedentary and poor dispersers (Myrberget 1976). Large stretches of forest or mountains are likely barriers in their movement into new areas and we do not expect them to naturally establish in regions they are not currently occupying. The amount of quality habitat in Norway for both partridge and pheasant will probably increase due to initiatives with pollinator zones and possibly also climate change, but this is uncertain (see paragraph "Prospects of grey partridge and common pheasant future survival and establishment in Norwegian nature").

- Partridge and pheasant habitats are open semi-natural habitats which in Norway is mostly agricultural land. Partridges reside inside the agricultural matrix whereas pheasants prefer edge habitats towards woodland.
- Without intensive management efforts and releases, it is unlikely that the species will occupy ranges that they are not currently in.

4.2 Natural mortality in pheasants and partridges

Since partridges and pheasants reside in intensively managed semi-natural habitats and are in many regions hunted, mortality/survival estimates not directly impacted by humans have not been published. The overall management intensity with regards to habitat improvement schemes is unknown and most areas include either organized or opportunistic predator control and supplementary feeding in some form. Survival estimates are provided for pheasants in table 8 and for partridge in table 9.

Table 8 Survival estimates of wild common pheasants (adapted from J. R. Madden et al. (2018))

	(Clark, Bogenschutz, and Tessin 2008)		(Felley 1995)	(Wooley and Rybarczyk 1981)	(Dumke and Pils 1973)	(Foley et al. 2005)	(Hill and Robertson 1988a)	(Musil and Connelly 2009)			
Location	Palo Alto	Kossuth	Idaho	Iowa	Wisconsin	Colorado	UK	US	Mean	Max	Min
Early life Weeks 1-6	0.46	0.37	0.25						0.36	0.46	0.25
Autumn survival (pre shooting)	0.86	0.86							0.86	0.86	0.86
Winter survival	0.66	0.61					0.65		0.64	0.66	0.61
Spring	0.79	0.84	0.67	0.544	0.71	0.674			0.7	0.84	0.54
Breeding season			0.79	0.697	0.856	0.833		0.4	0.72	0.86	0.4

Table 9 Survival estimates of wild grey partridge.

			(Potts and Aebischer 1995)		(Bro et al. 2001)	(Buner and Schaub 2008)	(Aebischer and Ewald 2004)			
	UK ÷ herbicides	UK + herbicides	Sussex	France	France	Switzerland	Sussex	Mean	Max	Min
Chick survival	0.49	0.32	0.28			0.58	0.29	0.39	0.58	0.28
Females Spring-Summer				0.25	0.65		0.70	0.53	0.70	0.25
Juveniles, 1-2 months						0.88		0.88	0.88	0.88
Juveniles, 2-3 months						0.82		0.82	0.82	0.82
Adult, Monthly						0.90		0.90	0.90	0.90
Females winter							0.59	0.59	0.59	0.59

- Survival estimates from populations untouched by management in some form or another does not exist and survival estimates for the different life stages vary as would be expected.

4.3 Mortality in captive-bred pheasants and partridge vs wild stocks

Survival in partridges and pheasants is substantially lower in captive-bred and released birds than in wild populations (i.e. released birds are considered wild after one year). Similarly, hand-reared individuals produce less offspring. A Finish study comparing radio-marked individual wild and hand-reared partridge found that the survival probability for hand-reared partridges was nearly ten times lower than that of wild partridges (Putaala, Turtola, and Hissa 2001). In this study, mortalities in hand-reared partridges were caused by starvation and predation by predominantly goshawk (*Accipiter gentilis*) and cats (*Felis catus*). Similar patterns have been reported from Scotland (Parish and Sotherton 2007) and The Czech Republic (Rymešová, Tomášek, and Šálek 2013). A study investigating breeding success in wild versus hand-reared pheasants in England and Ireland found wild males to be 2-5 times more successful in breeding than hand-reared ones. Hand-reared females were three times more vulnerable to predation during summer than their wild counterparts and wild females were four times more productive that hand-reared ones (Hill and Robertson 1988a). This pattern was confirmed in Sweden where wild females survived better and had higher brood survival than broods of reared females (Brittas et al. 1992).

The methods used for rearing and release might affect survival of partridge post release. In Switzerland they compared three different techniques during a reintroduction program; 1) translocation of wild adults, 2) captive parent-reared adults as family groups and 3) fostering of captive parent-raised offspring to wild barren pairs. They compared survival of the groups under different release techniques to wild hatched offspring. Survival was highest in the wild-hatched birds (0.90) whereas chicks fostered by wild parents and translocated birds performed slightly poorer (0.86 and 0.82 respectively) whereas survival of captive-reared adults released as family groups was significantly lower (0.70) (Buner and Schaub 2008).

- Survival rates reported are substantially lower in captive-bred birds than wild birds
- Optimizing post-release conditions and release techniques can mitigate poor survival

4.4 Mortality in captive-bred pheasants and partridge versus wild-living Tetraonidae

Tetraonidae and *Phasianidae* species are r-selected species which means that they have fast life histories and short life expectancy in the wild. They have great reproductive potential by reproducing their first year and laying large clutches of eggs. Some species also re-lay a clutch of eggs if the first clutch is lost. Most years, however, this reproductive potential is not realized. Mortality rates of eggs, chicks, juveniles and adults are normally high, and the proximate cause of death is most often predation. However, lack of food (Potts 1996), weather (Wegge and Kastdalen 2007) or habitat deterioration (Bro et al. 2004) can modulate mortality rates. For species residing in intensively managed habitats like pheasants and partridges, causes of mortality can also include human activities like mowing (e.g. Potts, 2012).

Annual mortality rates in wild *Galliformes* of the boreal forest and alpine regions vary greatly between years and egg and chick mortality varies in synchrony with the timely outbursts of voles and lemmings. This temporal driver is largely lacking in agricultural areas in southern Scandinavia (e.g. Erlinge, 1987) and predation rates on partridge and pheasant should therefore be less variable between years. Adult mortality also varies between years, but adults are more prone to predation from raptors which are not affect by the access to voles as mammalian predators are. For capercaillie and black grouse living in boreal woodlands, the number of chicks per hen in august decreased from 3.1 to 1.2 for capercaillie and from 3.5 to 1.6 for black grouse between 1930s and 2012 (Jahren et al. 2016). For adult capercaillie hens, annual mortality rates varied between 29 and 59 % whereas black grouse hen mortality varied between 31 and 58 % (Jahren et al. 2016).

An eight-year study following > 250 willow ptarmigan chicks just after hatching found that 33 % (range 28.9 - 80.4 %) died the first two-three weeks. 73 % of those died from predation (Steen and Haugvold 2009). Similarly, a three-year study found that 57 % of capercaillie chicks died within their first month of which 90 % were killed by predators (Wegge and Kastdalen 2007).

County-wise, annual censuses (Nilsen, Vang, and Breisjøberget 2023; Nilsen, Vang, and Kjønsberg 2023) of willow ptarmigan (1999-2022) and woodland grouse (2006-2022) in Norway showed mean chick production for willow ptarmigan to vary between 0 and 2.46 chicks per pair. For black grouse, chick production varied between 0 and 3.5 chicks per hen whereas capercaillie hens produced between 0 and 2.67 chicks.

- *Tetraonidae* and *Phasianidae* species live fast and die young. Populations can grow rapidly due to their great reproductive potential.
- The potential for population growth is limited primarily by predation.
- Mortality rates between the species are comparable but in Norway, wild-living *Tetraonidae* live in less stable environments than *Phasianidae* and probably experience larger variation in vital rates. This gives populations of *Tetraonidae* time to recover and grow between bouts of higher mortality rates.

4.5 Changes in captive-bred and released pheasant and partridge mortality

In Europe, partridge and pheasant conservation status is least concern (LC), mainly due to their large spatial distributions (IUCN 2022). Locally however, populations have drastically declined the past decades (Kuijper, Oosterveld, and Wymenga 2009; Ronnenberg, Strauß, and Siebert 2016). Many of these populations have been supported via programs releasing captive-bred birds or by translocation of wild birds and so mortalities on both wild and released birds have likely increased. Three major causes jeopardizing population recoveries have been identified. Firstly, partridge chick survival has declined due to lack of food stemming primarily from pesticide use (Potts 1986), deterioration of habitats have deprived partridges and pheasants of important habitat structures during different parts of their life cycle (Rands 1986; Ronnenberg et al. 2016) and thirdly, increased predation rates are depressing the survival of eggs, chicks, juveniles and adults (Robertson et al. 2017; Tapper, Potts, and Brockless 1996). Altogether, these causes ultimately track back to the intensification of agricultural practices that was initiated in the 1950s.

- Trends in captive-bred partridge and pheasant mortality have likely increased along those of wild birds the past decades.

4.6 Mechanisms underlying increased mortality in captive bred and released pheasants and partridge

Breeding animals in captivity can result in physiological, anatomical, genetical, or behavioural differences compared to their wild counterparts, which may hinder their ability to survive in the natural environment upon release. Captive-bred chicks not reared by parents or foster parents lack behavioural imprinting that shape e.g. vigilant behaviours or feeding ecology (Slaugh et al. 1992). Captive-bred birds can also be heavier and have lower flying endurance than wild birds resulting from higher-quality food and less exercise (Putaala and Hissa 1995). Similarliy, captive-bred chicks sustaining on inappropriate diets can lead to anatomical maladaptation to a natural diet (Liukkonen-Anttila, Putaala, and Hissa 2002). Keeping generations of captive-bred birds without introducing new genes will cause selection on specific traits and genes that deviate from selection in nature on wild birds. Selection under captive breeding circumstances can be powerful. An extreme example is the well-known Russian farm-fox domestication project, the sixth generation of domestication brought about foxes that sought human attention and behaved similar to dogs (Trut 2000). Albeit, several protocols and techniques have been developed to mitigate potential impacts of captive-breeding on the post-release survival of birds (see chapter 5.3).

- Captive-breeding can cause unwanted changes in behaviour, physiology, anatomy and genetics that cause maladaptation to the environment outside breeding stations.
- A number of techniques and protocols have been developed to mitigate effects of captive breeding on post-release survival.

4.7 Density dependent mortality in restocked pheasant and partridge

Density dependent effects refers to the way the number of individuals in an area or the population density impacts the behaviour, population growth or survival of the population. These effects can result from interactions between individuals within the population or between the population and its environment.

Due to the low number of released birds, the most relevant factors relating to population density under conditions that have been prevailing in Norway is inverse density dependent factors like the Allee effect which describe how low population densities can affect population growth negatively. Low population densities can reduce the success of finding a mate and therefore reduce individual fitness. Low population densities can also inhibit cooperation between individuals in antipredator behaviour like alarm calls or flocking during winter. A UK-study found that group size was the major determinant of survival in partridge and that smaller groups allocate less time to vigilance (Watson, Aebischer, and Cresswell 2007).

Density dependent reproductive success have been observed in partridge (Bro et al. 2003; Panek 1997). This can be related to habitat quality because habitat properties can affect thresholds for density dependent effects. For instance, individual partridge interacted less frequently in populations with lower densities or in habitats with where ground vegetation cover prevented them from seeing each other. Also, high density populations in poor habitats had more overlap in home ranges (Jenkins 1961). Individuals in artificially high (i.e. restocked) population densities of birds can therefore potentially attract predators both due to behaviour and numbers but again, this is unlikely to have been the case in Norway. Should releases continue in an upscaled fashion however, this need to be investigated.

- In Norway, inverse density dependent factors have probably been prevailing.
- Should densities in Norway substantially increase, several potential mechanisms can be triggered, and this should be investigated.

4.8 Difference in factors affecting captive-bred and wild-living pheasant and partridge negatively

No difference except poorer demographic rates and a wider range of potential predators.

4.9 Mitigating mortality risks in restocked birds

It is well known that captive bred and released gamebirds experience lower survival and reproductive rates compared with wild birds of the same species in the same area. Birds bred in captivity have limited experience of predators as opposed to chicks brooded by a wild female and they are often fed commercial poultry food which can lead to nutritional maladaptation to natural food (Liukkonen-Anttila et al. 2002). Reducing the predation risk by lethal control of natural predators as red fox is known to have a positive effect on survival of released birds (Tapper et al. 1996). It is also possible to develop alternative release methods where broods are released gradually into the wild or to surrogate parents (Browne et al. 2009). Habitat quality should also not be neglected (Rands 1985, 1986) but habitat is less clearly linked to survival of released birds than that of chicks hatched in the wild.

High mortality after release has been a reoccurring issue among conservationists and managers attempting to augment bird populations with captive-bred birds. Increasing post-release survival is key to success in many release programs. Different techniques that focus on both the period before and after released have been demonstrated to increase post-release survival. From Switzerland, there is evidence that exposing partridge chicks to unpredictable environments (i.e. unpredictable food supply), greatly improves their post-release survival compared to individuals with access to food *ad libitum*. The same study found that releasing birds earlier, in mid-September rather than mid-November, also increased post-release survival (Homberger et al. 2014). In a Finish study, partridge chicks fed exclusively on an invertebrate diet (fly larvae and ant pupae) were heavier, had more advanced development of primaries than chicks with low-invertebrate or fish diets. Invertebrate-fed chick were also similar in physical development to wild chicks (Liukkonen-Anttila et al. 2002).

Pre-release conditions can also propagate into later generations. Pheasants fostered by domestic chickens in the pre-release period had higher clutch and brood survival than birds reared under heating lamps in Sweden (Brittas et al. 1992). Translocation of wild birds is also an effective way to improve survival of restocked individuals post-release (Musil and Connelly 2009).

- Actions aimed at improving survival rates on restocked birds should focus on three aspects:
  - Legal predator control of generalist predators like red fox.
  - Habitat improvement schemes.

- Improvement of captive rearing. Chicks should be exclusively fed on invertebrates and in an unpredictable manner and chicks should be released to surrogate, wild parents.

- Translocation of wild individuals is a good alternative to captive-breed and release.

4.10 Effects of training pointing dogs on captive-bred and released pheasants and partridges

Nonlethal encounters with pointing dogs can potentially affect individual birds in several ways. Since prey species constantly need to trade-off between e.g. foraging behaviour and vigilance, a perceived risk of predation can elicit anti-predator responses like changes in home-range size and habitat use or displacement into refuge areas or bring about changes in time schedules i.e. time use to do x versus y. Brøseth & Pedersen (2010) found that willow ptarmigan (*Lagopus lagopus*) experiencing non-lethal encounters with hunters did not leave the hunting unit, but moved less and increased their use of habitats with better cover. The same patterns were observed in nontarget northern bobwhites (*Colinus virginianus*) during rabbit hunting (Mohlman et al. 2019). In another bobwhite-study, individuals learned to avoid hunters as time passed and in areas where hunters had been unsuccessful (i.e. more nonlethal encounters) the previous autumn, a sudden re-emergence of reproducing individuals in spring was observed (Radomski and Guthery 2000). Mohlman et al. (2019) suggested that heightened antipredator behaviour caused by nonlethal encounters may assist individuals in avoiding predators but the displacement into other habitat types and reduced movement may potentially inhibit fitness. To mitigate effects of nonlethal encounters, a practical advice is to provide birds with undisturbed areas as refuge from the risk-associated activity (i.e. pointing dog trials) (Casas et al. 2009). Pheasants, partridges and other gallinaceous birds that forage on the ground are more prone to predation than arboreal foragers. While nonlethal encounters with hunting dogs during trials or practice will cause stress due to increased perceived risk of predation, it is likely that such stress is handled well by the birds because encountering and avoiding predators is part of their evolutionary histories.

Pointing dogs mark and, on command, flush game birds without a subsequent chase. Wild woodland grouse, pheasants and partridges are flushed on regular intervals by natural predators like red foxes and pine martens. Contrary to the use of pointing dogs, these predators are highly active during spring and summer (Olsson, Willebrand, and Smith 1996). It is an established method to flush released game birds using pointing dogs to increase vigilant behaviour and flushing distance. Any negative physiological effects will naturally depend on the intensity and duration of dogs in a range. Repeatedly flushing the same individual the same day should probably be avoided, especially soon after birds have been released from captivity.

- Deliberately flushing captive-bred birds is a known measure to elicit antipredator responses and to heighten vigilance.
- Field surveys show that non-lethal encounters for wild individuals of similar species caused individuals to seek habitats with better cover. It is suggested that this can increase survival in the short term but potentially inhibit fitness in the long term.

- Pheasants and partridges should handle stress from non-lethal encounters well since it is part of their evolutionary histories.

5 Animal welfare aspects in breeding and rearing common pheasants (*Phasianus colchicus*) and grey partridges (*Perdix perdix*)

5.1 Describe welfare needs of pheasants and partridges during rearing and breeding in captivity

Good animal welfare is an animal free from hunger and thirst, discomfort, pain, injury and disease, fear, distress, and free to express normal behaviour. These principles also apply for breeding and rearing pheasants and partridges in captivity for subsequent release into the wild (FAWC 2008). A high standard of welfare should apply both during the life of the birds and at their point of death. For most poultry, such as those raised for meat or eggs, the bird is farmed under controlled conditions permitting the farmer to continuously monitor and adjust living conditions to ensure intact welfare for the entirety of the animal's life up to slaughter. In other circumstances the farmer only has direct control over the animal for part of their lifespan, and the rearing ends when they are released into the wild (Pennycott, Deeming, and McMillan 2012). This applies to a variety of different re-wilding, conservation, and re-introduction programs both nationally and world-wide, but additionally to the situation where game birds are reared and released for dog training which has been the situation in Norway, or for recreational hunting in Sweden, Denmark, United Kingdom and several other countries. Pheasants and partridges are *Galliformes*, similar to chickens and turkeys, but in contrast with these birds, the goal is to select for wild behaviour instead of domesticated traits. And consequently, these birds need different housing and rearing conditions to keep animal welfare intact during breeding and rearing (Matheson et al. 2015). Although, the consensus is that there is still very little research and understanding of the actual needs of game birds reared in captivity (Deeming 2009; Defra 2010; FAWC 2008; Madden, Santilli, and Whiteside 2020; Matheson et al. 2015; Pennycott et al. 2012), and the following assessment can thus only evaluate what we do know and identify the current knowledge gaps for breeding and rearing pheasants and partridges. Due to the species differences between pheasants and partridges, especially during the breeding and pairing up stage (Fuller and Garson 2000; Matheson et al. 2015; G. Potts 2012) we will evaluate breeding and rearing individually for each species.

- Good animal welfare principles apply for breeding and rearing of pheasant and partridge as they do for domesticated species.
- The goal with breeding and rearing of pheasant and partridge is to select for wild behaviours and this require different rearing conditions compared to domesticated species.
- The knowledge base for understanding needs of game birds reared in captivity is low.

5.2 Breeding and rearing housing systems

5.2.1 Pheasants

Norwegian breeding and rearing of birds are probably most closely compared with Swedish breeding, and approximately 1/3 of the birds released in Norway are imported from Sweden. There are currently no studies from Norway about breeding and rearing pheasants or partridges. Pheasant breeders and rearers in Sweden diversify by having either solely chicks (rearing of chicks to release), breeding pheasants only during the breeding season or keeping breeding birds year-round. A study published in 2009 aimed to quantify and summarize Swedish game bird breeding and rearing and reported that the median number of breeding birds in these facilities were 300 during the breeding season, and 200 during the rest of the year. The breeding pheasants were purchased from other farms, caught from the wild, or recruited from their own farm. The average number of chicks kept at these farms in Sweden were 3976 (Wiberg and Gunnarsson 2009), whereas in Britain these numbers vary from 5500 to over 100,000 chicks per farm (Pennycott et al. 2012), making Scandinavian and British conditions quite different both in scale and production systems.

Breeding pheasants form harems in late winter or early spring, and are typically kept in floor based aviaries or cages (Matheson et al. 2015; Wiberg and Gunnarsson 2009). Concern has been raised over the use of cages for breeding and rearing pheasants. Pheasants are selected to keep their semi-wild behaviour and flying characteristics, making both animal welfare groups and some members of the game bird industry itself advocate that rearing pheasants in cages is poor animal welfare, even though it can decrease disease prevalence in a flock (Matheson et al. 2015). The stocking density of pheasants varies between farms, but for breeding adults seems to vary from 0.06-5.6 birds/m^2 per breeding bird reported from the Swedish study (Wiberg and Gunnarsson 2009), whereas British reports varies from smaller farms with 3.375 m^2 per bird down to 1.255 m^2 per bird in larger systems (Deeming 2009; Pennycott et al. 2012). The ideal sex ratio for commercial breeding has been recommended to 7:1, and the recommended space requirement per bird for fertility is 4.5 – 6 m^2 (Pennycott et al. 2012). Although, keeping pheasants in these breeding flocks is not the natural condition for this species, and it is expected that there is a tremendous potential in increasing both animal welfare and productivity with more research into optimum space requirement for these birds (Pennycott et al. 2012). In the wild harem sizes for pheasants is reported to be 1:1-5 (Matheson et al. 2015). For rearing chicks the Swedish study reported a stocking density of 0.48 – 48 birds/ m^2 (Wiberg and Gunnarsson 2009), whereas British reports vary from 18 – 64 birds/ m^2 (Pennycott et al. 2012).

Farms rearing chickens from day old to release typically have heated brooder huts with access to unheated shelter pens and large netted grass runs. These grass runs, or aviaries, should mimic the ecosystem the birds will be released in. Pheasants are forest-edge birds (Fuller and Garson 2000), and the grass run should include sufficient amounts of vegetation and branches the birds can perch on. It should be spacious enough to avoid crowding and unwanted pecking behaviour. The net should be flexible, stand at least 170 cm tall, with sufficient amount of shelter for every bird, meaning that the roof both has a mesh net side and an intact roof side. For the netted parts we recommend double netting, to avoid direct contact with wild birds. These systems should be moved to fresh grass after some years use, and the grass runs should preferably be disinfected annually with calcium to prevent run-off to nearby ecosystems and improve the soil and grass quality in the aviary. Day old chicks should be confined to brooder areas for up to a week, before given access to shelter pen and grass runs (Pennycott et al. 2012). Appropriate bedding in the heated brooder huts should be clean, dry, non-toxic and tangle free (Defra 2010; FAWC 2008), and British studies report using wood shavings, straw or chopped card board for rearing chicks (Pennycott et al. 2012). The British study reported a stocking density of 18-64 chicks/m^2 in these brooder huts (Pennycott et al. 2012). Welfare codes require that chicks are reared with appropriate size, stocking densities and facilities in both brooder huts and aviaries, including appropriate environmental enrichment to ensure good health and welfare (Defra 2010; FAWC 2008), but do not specify actual stocking densities or requirements. Danish regulations specify stocking densities for pheasants in aviaries in the following standard: 3-9 week old birds maximum 3.5 birds per m^2, 10-13 week old birds maximum 2 birds per m^2, 14-16 week old birds maximum 1 bird per m^2, and over 16 weeks maximum 1 birds per 3 m^2 (Anon 2015). These regulations can be used as a guideline, but more research is needed to establish suitable stocking densities for pheasant chicks, breeding birds and harem sizes in captivity to ensure optimal animal welfare during the captive life stage.

- One third of the pheasants released in Norway are imported from Sweden
- Breeding stocks of pheasants in Sweden originates both from wild and farmed strains
- Breeding conditions for pheasants vary and further research have potential in increasing both animal welfare and productivity.

5.2.2 Partridges

In Sweden, rearers either report keeping breeding birds year-round, solely for breeding season, or that they only rear chicks. The number of breeding birds at each facility varied from 20 to 1600 during the breeding season, and 20 to 1000 during the winter season. All breeding birds were recruited from the rearer's own farm (Wiberg and Gunnarsson 2009). Chick rearers in Sweden reported an average of 1250 birds per facility (Wiberg and Gunnarsson 2009). Partridges in the wild are grassland and field birds and form monogamous pairs in early winter, where both the male and female are involved in nesting (Dahlgren 1990). In the wild these pairs will stay together through the breeding season, but not outside of the breeding season (Matheson et al. 2015). It is therefore not recommended to keep partridges coupled up in cages outside of the breeding season, as this can lead to social stress. The Swedish study reported that some farms kept breeding birds in wire mesh cages, others in cages combined with an outdoor run, or aviaries, for the breeding birds during the breeding season. It was also reported that partridges were kept coupled up in cages year-round (Wiberg and Gunnarsson 2009). At 61% of the farms in the study chicks had access to both indoor and outdoor areas, with a stocking density ranging from 0.8 – 9.4 birds/m^2 for breeding birds and 0.95 – 31 birds/m^2 for chicks (Wiberg and Gunnarsson 2009). The Swedish study reported that about 30% of the rearers provided breeding birds with environmental enrichment, whereas approximately 60% of the rearers provided environmental enrichment for the chicks. This could include, grass, sand, other types of vegetation that could be used for perching, artificial perches, straw, wood shavings and gravel. The actual space needs for partridges are understudied. Danish regulations specify stocking densities of partridges to the following standard: 4-8 week old birds maximum 20 birds per m^2, 9-13 week old birds maximum 13 birds per m^2, and over 13 weeks maximum 7 birds per m^2 (Anon 2015). These densities can be deviated if the partridge chicks go together with a breeding pair in a bottomless cage on grass with a minimum dimension of 4 m^2. Partridges naturally breed as a pair and their instinct is to raise chicks together in breeding pairs. In captivity breeding pairs easily "adopt" newly hatched chicks regardless of kinship. The cage used for a breeding pair and a flock of chicks needs to have enough shelter so every bird can be covered, but at the same time every bird should have access to space with only a mesh net roof. These shelter vs mesh net roof regulations stand for partridge aviaries as well. The cage should be moved when necessary, so the birds always have access to fresh vegetation (Anon 2015). These regulations can be used as guidelines before new studies on partridge stocking densities are available. We recommend keeping the social behaviour of partridges intact, and letting chicks grow up with a nesting pair regardless of actual kinship seems to be appropriate and good animal welfare for this species.

- Breeding stocks of partridges in Sweden originates mostly from farmed stocks
- Breeding conditions for partridges vary and further research have potential in increasing both animal welfare and productivity.
- Partridge form pairs part of the year and this need to be replicated in captivity. Chicks should also grow up with parents or surrogate parents.

5.3 Describe environmental factors important to animal welfare during breeding and rearing, both inside and outside

5.3.1 Environmental enrichment

Most reports agree that there are too little research into welfare in game bird rearing (Defra 2010; FAWC 2008; Madden et al. 2020; Matheson et al. 2015), and a large potential to increase welfare parameters with more research filling knowledge gaps. Currently, welfare assessments are mostly based on mortality, levels of feather-pecking, development, stocking densities, light exposure, provided perches, and high protein diets. Feather-pecking is reported as a problem from most studies evaluating welfare in game bird rearing (Madden et al. 2020). The Swedish study reported feather-pecking from more than a third of pheasant and partridge rearers (Wiberg and Gunnarsson 2009). Feather-pecking and subsequent skin injuries have been shown to decrease with increasing floor space (Cain et al. 1984; Kjær 2004), and with environmental enrichment using sight barriers inside the pens (Deeming, Hodges, and Cooper 2011). Branches of pine trees and vegetation has also been used as environmental enrichment to reduce feather-pecking. A Danish study observed that pheasant chicks start pecking each other during their first day of life, and suggested that early access to environmental enrichment such as tree branches and vegetation can decrease this behaviour (Kjær 2003). In Swedish, Danish, as well as British rearing systems the employment of beak rings, or bits, preventing the birds from closing their beaks, have been common to prevent feather-pecking (Kjær 2003; Pennycott et al. 2012; Wiberg and Gunnarsson 2009). Although these are now illegal to use in Denmark (Anon 2015; FAWC 2008), and in general advised against using routinely (Defra 2010).

Improving welfare in pheasant and partridge breeding and rearing is increasingly prioritized, and a British study evaluated the presence of sight barriers as an environmental enrichment for pheasants. Straw bales and metal sheets were placed in the middle of the pens in a >-< shape to prevent birds from seeing the whole flock at all times, and thereby provided refuge, less aggression, and privacy for courtship and copulation (Deeming et al. 2011). The study did not establish a relationship between the sight barriers and mortality, but plumage scores significantly improved, time perching increased, aggression reduced and birds exhibited less pecking behaviour compared with control pens (Deeming et al. 2011). All housing facilities should provide ventilation (natural or manually or automatically controlled fan), and allow a minimum continuous period of night-time darkness of 8 h every day to allow birds to rest (FAWC 2008; Pennycott et al. 2012). All birds should have access to perches and dust baths (Defra 2010).

A finish study compared the anatomy and physiology of partridges reared in captivity with wild partridges. Captive birds were heavier, with larger breast muscles, but relatively lighter hearts and livers than wild birds. Wild birds had longer small intestines, longer caeca and heavier gizzards than reared birds. The pectoral muscle of wild partridges had higher glycogen content and cytochrome-c oxidase activity, indicating better flying endurance compared to captive birds (Putaala and Hissa 1995). The captive birds had only been in captivity 1-2 generations, excluding a substantial genetical component in the results. The study reiterates the importance of a natural diet and large aviaries with perches and vegetation to possibly prevent these captive anatomical and physical changes. Another study found that the addition of natural elevated perches in the rearing pens mimicking natural variation in habitat complexity and led to morphological, cognitive and behavioural changes, culminating in increased survival in the wild for released pheasants (Whiteside, Sage, and Madden 2016). In pheasants reared with perches, anatomy developed to fly up to the higher branches and cope with prolonged roosting. They had higher propensity to roost off the ground at night, and more accurate spatial memory. Consequently, birds were at a reduced risk of terrestrial predation (Whiteside et al. 2016).

Stocking densities are understudied, and prioritizing enough space is most likely extremely important to prevent pecking, social stress, and injuries. Additionally, we recommend species specific environmental enrichment. Pheasants as a forest-edge bird should have a forested aviary, with vegetation such as branches, shrubs, heather, and trees, stimulating natural behaviours including perching and escaping from dangers to tree branches. Partridges as a grassland bird needs dust baths, sufficient fresh grass, vegetation, and shrubs in their bottomless cage or aviaries.

- Pheasant and partridge welfare during rearing is understudied.
- Most assessments of animal welfare in traditional rearing-techniques report stress-associated behaviours.
- The diet provided during captive-breeding of partridge in Finland changed their anatomy and physiology within 1-2 generations.
- Stress associated behaviours will decline by increasing available space and providing environmental enrichments tailored to the target species. Optimization of diets will reduce physiological and anatomical changes in partridge.

5.3.2 Diet

In Sweden, breeding birds and chicks of both pheasants and partridges are mainly fed commercial diets (pheasant or turkey feed). Supplements were mainly egg- or seashells, or chopped, boiled hen eggs to chicks (Wiberg and Gunnarsson 2009). In the wild both pheasants and partridge chicks eat a diet mainly consisting of invertebrates, and it has been suggested to supplement chicks with invertebrates during their first week of life to learn this behaviour and to promote natural growth (Liukkonen-Anttila et al. 2002; Wiberg and Gunnarsson 2009). Older wild birds mainly subsist on plants.

We recommend that both pheasants and partridges are fed under a sheltered roof, to avoid contact with wild birds. Additionally, water should not be untreated surface water/water reservoirs, to avoid any contagion from wild birds. The birds should also be watered under sheltered roof. We recommend supplementing commercial feed with natural diets including invertebrates and plants.

- Rearers should strive to match natural diets when rearing chicks of both species. This will promote behaviours and growth like wild chicks. Chick diets consist mainly of invertebrates and diets should be exclusively invertebrates the first week of life.

5.3.3 Describe measures to improve animal welfare in pheasant and partridge farming

This section will try to summarize recommendations already described in this report. For references, please refer to the text in Chapter 6: “Animal welfare aspects in breeding and rearing common pheasants (*Phasianus colchicus*) and grey partridges (*Perdix perdix*)”.

To encourage wild behaviour pheasants should be kept in aviaries with both inside and outside areas, and not be housed in cages. Outside areas should have a view of the natural world to expose the birds to raptors and other natural stressors (mesh netted roof). The aviary should mimic the landscape natural for the birds, for pheasants this means forested vegetation, numerous branches for perching (can be a combination of natural branches and man-made perches), spacious enough to avoid social stress, and access to dust baths. The exact stocking density for chicks, breeding birds, and sex ratio for harems are understudied, and we stress that more studies needs to be completed on this important animal welfare question. Sufficient amount of space will most likely make beak rings unnecessary.

Partridges should not be coupled up outside of breeding season, as this is unnatural for the species and leads to social stress. During the breeding season they can be coupled up in cages measuring at least 4 m^2, and newly hatched chicks can be placed with the breeding pair in family groups (unrelated to kinship). Although, the exact stocking density for intact animal welfare is unclear and needs to be researched further. The cage needs to be on fresh grass and should be moved often so the animals always have access to fresh grass and vegetation and dust baths. It needs to have enough shelter for every bird, and access to unsheltered area with a wire mesh roof. Chicks reared without an adopting breeding pair should similarly to pheasants have an aviary with sufficient amount of grassland vegetation, and a combination of shelter and wired mesh roof. All birds must fit under the shelter, and all birds must be fed under the shelter to prevent wild birds coming into contact with food or water. For suggested stocking densities see chapter 6, section 6.2, although similarly for pheasants, the exact stocking densities needed to keep animal welfare intact is also not known for partridges, and further research is required.

Keep chicks of both pheasants and partridges in warmed brooding huts until they are about one week old, before transfer to outside grass runs/aviaries. The warmed brooding huts should contain appropriate bedding which should be clean, dry, non-toxic and tangle free such as wood shavings, straw or chopped cardboard.

In the wild both pheasants and partridge chicks eat a diet mainly consisting of invertebrates, and we suggest supplementing chicks with invertebrates during their first week of life to learn this behaviour and promote natural growth. Similarly, adult birds in the wild mainly subsist on plants, and the diet in captivity should include appropriate plant material in addition to commercial feed to mimic the wild situation. A natural diet and spacious aviaries with natural vegetation adapted to the species (forest vegetation for pheasants and grassland vegetation for partridges) can possibly prevent captive changes observed in anatomy and physiology. Although, this is a topic for more research and we strongly recommend more research into improving animal welfare for pheasants and partridges reared for release into the wild.

Optimal health is an important part of good animal welfare. To keep animal health intact in captive rearing of pheasants and partridges we present the following recommendations, which is elaborated in Chapter 4 of this report "Animal health during release, farming, import, and transport of pheasants and partridges". Hygiene is important to avoid disease in the flock, and thorough washing of eggs before entering the egg incubator is important. The incubator area should be separate from other areas of the farm with live birds. Additionally, the general hygiene on the farm is important. Visitors should disinfect shoes in foot baths, or ideally wear boots and coveralls belonging to the farm. A changing room for this should be present. Protocols should be kept for all visitors, and everyone entering the farm should wash their hands. The aviaries should have double netting to ensure no wild animals or birds can have direct contact with the farmed pheasants or partridges. All food and water should be fed under the sheltered part of the aviary (or cage for partridges), and measures should prevent wild animals or birds' access to these. Ventilation and lighting should follow laws and regulations for commercial rearing of poultry in Norway, specifically for breeding birds overwintering at the farm. We recommend regular controls of the birds by a veterinarian, at a minimum before release of the captive birds into the wild. The aviaries should be disinfected annually with calcium to prevent runoff to nearby habitats.

Transporting birds for release is a potentially stressful life stage, which should be handled with care. At the time of release all birds should have a final inspection by a veterinarian to ensure they are healthy and fit for release, ready for transport, and appropriate feather development. Birds should be captured and carried one at the time and placed into an approved transport container appropriate for size and number of birds that protects them from injury, are clean and secure, well ventilated, and offers protection from weather. Personnel involved with catching and handling must be competent to minimize stress for the birds. Time in transit should be kept to a minimum, while complying with Norwegian legislation for transporting live birds (up to 8 h for adult birds and up to 24 h for chicks younger than 48 h since hatching).

We strongly recommend acclimatization pens for pheasants and partridges after transport and before final release. These acclimatization pens give the birds a chance to recuperate after transport, get physiological stress levels caused both by transport and by the release into a new environment back to baseline levels, before they are allowed to leave the acclimatization pen on their own account after approximately two days. For birds reared in aviaries, the acclimatization pen should be sized similarly to the aviary. For partridges reared in cage with a family group, they should be acclimatized in a cage of similar size, and the family group should be released together over the span of a few days, including the breeding pair.

- Rearing conditions should approximate natural conditions. This include pens with inside and outside areas. Also, stimuli and habitat features should be present, and the birds should have the possibility of being exposed to natural stressors like raptors.
- Feather-pecking can be indicative of insufficient space. Habitat enrichment can mediate stress caused by insufficient space.
- Farm hygiene is important. This include separation of incubators and birds, washing of eggs before incubation, hygiene and protocols for farm visitors and excluding wildlife from accessing food and water.
- Transportation of birds from farms to acclimatization pens should follow Norwegian legislation.
- Acclimatization pens should be used for soft-release of the birds.

5.3.4 Assess the impact of transport for pheasants and partridges

The final step of rearing pheasants and partridges is the transport for release. Transportation can be perceived stressful for animals not used to other environments, and it is important to follow guidelines for safe transport, keeping animal welfare and biosecurity intact. The “Code of Practice for Welfare of Gamebirds Reared for Sporting Purposes (2010)” reviews catching, transportation and preparation for release of captive bred game birds (Defra 2010). In brief, birds must be transported in containers appropriate for size and number of birds that protects them from injury, are clean and secure, well ventilated, and offers protection from weather. Personnel involved with catching and handling must be competent to minimize stress for the birds. Catching and carrying several birds at once is poor animal welfare. Time in transit should be kept to a minimum, while complying with Norwegian legislation for transporting live birds. At the time of release all birds should have a final inspection by a veterinarian to ensure they are healthy and fit for release, ready for transport, and appropriate feather development. Birds unfit for transport due to disease, health, or injuries must not be transported or released. This ensures good animal welfare and prevents release for possibly sick and contagious birds.

The quantity of pheasants released in Great Britain (39-57 million/year) are not comparable to the Norwegian situation (4-6000/year), but welfare regulations developed in Great Britain and other European countries can easily be transferred to Norway. Studies have investigated stress in gamebirds related to transport, suggesting the importance of intact animal welfare during this potentially stressful life stage. Pheasants crated and transported for 3.5 h (140 km) significantly increased the stress hormone corticosterone in droppings compared to baseline levels. After transport metabolites of corticosterone returned to baseline levels within 3 h. However, a second peak occurred 18 to 26 h after release, likely related to the birds experiencing a new environment.

The corticosterone levels returned to baseline again after 6 h, reflecting how the birds adapted to this new life stage in the wild (Volfová et al. 2022). A similar response was documented for transport of partridges. This study also showed how survival the first month was better for animals undergoing a “soft release”. The birds undergoing a soft release were released into acclimatization pens after transport, and stayed there for 33 h before release, which again lowered stress levels before they were released into the wild. The birds were allowed to leave the acclimatization pens after 33 h on their own account once the doors were opened (Jenni et al. 2015). Similar physiological changes from homeostasis was also documented in various haematological blood levels in pheasants during transport (Voslarova et al. 2006). These studies highlight the importance of a soft release and utilizing acclimatization pens for at least 33 h and avoid the stressful situation of a direct release into the wild after transport. The soft release allows birds to acclimatize, destress, and reach normal physiological levels before leaving the acclimatization pens on their own account for final release. We recommend a soft release with acclimatization pens for both pheasants and partridges.

- The time birds spend in transit between farms and release pens should be kept to a minimum.
    - Containers should be of appropriate size and protect birds from injury and weather, be clean and well ventilated.
- Birds should be inspected by a veterinarian before release.
- Transportation causes stress but stress responses alleviates completely three hours after transportation has ended.
- Release of birds from pens causes stress that peaks 18-26 hours after release. Six hours after that, stress hormones are again at baseline levels.
- The use of acclimatization pens reduce stress during release of birds.

6 Animal health during release, farming, import, and transport of pheasants and partridges

6.1 Introduction: A review of disease in reared pheasants and partridges

The relationship between an animal and a pathogen is influenced by a great variety of factors. Some of these factors are features of the pathogen, some are features of the animal, whereas others are not directly related to either. The latter refers to environmental factors. This formulates the concept that animal, pathogen, and environment, are all interconnected in development of disease, and the concept is illustrated as the epidemiological triangle (Merrill 2021). This means that disease can be context dependent. In certain contexts, or situations, the relationship between pathogen and animal is benign, while it may be very harmful to the animal in other situations. Factors determining resistance to pathogens include the animal's genotype, age, sex, nutritional condition, physiological and/behavior stress, immunity, weather conditions, and climate. In the following we will do a brief review of the disease threat to pheasants and partridges reared in captivity for release, both during rearing and during life stages in the wild. Our review is mainly limited to European conditions, as we see these as most relevant for rearing and breeding gamebirds in Scandinavia. We will also suggest a regime to prevent disease in captivity by keeping environmental factors optimal to prevent disease, with obvious subsequent beneficial effects post-release. Very few reports are available for Scandinavian breeding systems, limiting this evaluation of the current situation.

Starting October 2020 and still ongoing (February 2023), Europe has experienced the largest epidemic of the World Organization for Animal Health (WOAH) notifiable disease highly pathogenic avian influenza (HPAI) ever recorded. Its geographical scope is similar to the previous major outbreak in 2017–2018. Cases have been diagnosed across Europe, with over thousand outbreaks reported in poultry, and more than 2,000 in wild birds. The most common virus type identified in the early stages of the epidemic was HPAI H5N8, whereas H5N1, emerged as the dominant virus by the fall 2021 (European Food Safety Authority et al. 2022). In January 2021 HPAI was detected in poultry in Finland for the first time when virus type H5N8 was detected on a pheasant farm, most likely spreading from a previously released pheasant. The outbreak was controlled, but released pheasants with HPAI H5N1 showed up again in September when thousands of newly released pheasants emerged dead (Finnish Food Authority 2022). During the same European outbreak, HPAI H5N8 was detected in a pheasant farm in Skåne, Sweden (Grant et al. 2022). During the HPAI outbreak in Europe in 2017-2018, several pheasants recently released from captivity were reported sick with H5N6 in Denmark (Liang et al. 2021).

Norway had the first occurrence of HPAI in November 2020 in a wild goose in Western Norway (Rogaland), and since then more cases have been reported in wild birds. During the 2022/2023 winter season, nine birds had been diagnosed with HPAI (period between October - December) ranging from Stavanger area in the south to Nordkapp in the north (Granstad, Rømo, et al. 2023), showing a nationwide distribution along the coastline. When this report is being finalized February 2023, 11 more cases have been diagnosed since December (Veterinærinstituttet 2023). The Norwegian Food safety Authority has recommended infected zones/ mandatory curfew for domesticated poultry in regions in Rogaland, Oslofjorden, and Trondheimsfjorden, where there is a high risk of wild and infected migratory birds can encounter domesticated poultry (S Granstad et al. 2022), and the legislation for infected zones for HPAI (and Newcastle disease) was released in June 2022 (Anon 2022a).

Newcastle disease (ND) is an extremely contagious avian viral disease caused by avian paramyxovirus 1. Less virulent strains circulate among wild birds, especially among wild pigeons (*Columbiformes*), which can cause less severe outbreaks. ND is a WOAH and Norwegian notifiable disease and outbreaks have been reported from commercial game bird production in Great Britain (Aldous et al. 2007; Irvine et al. 2009). Additionally, an outbreak of ND was reported from Denmark on an island with 12.000 released pheasants with 56% mortality (Jørgensen et al. 1999). These outbreaks raised the question if game birds could be a route of transmission into commercial poultry settings due to semi-feral rearing systems, potentially bringing them into contact with both wild birds and poultry species. Subsequent clinical trials could not support this hypothesis. Partridges did not demonstrate transmission between birds, and pheasants and partridges did not seem to shed high enough levels of infectious virus for onward transmission to naïve game birds (Ross et al. 2023). The increased surveillance for HPAI, discovered ND in one pheasant and four pigeons in Sweden in 2021 (Olsson 2022), but ND does not seem to be prevalent in European game bird populations. Low virulent strains from *Columbiformes* can contaminate game birds. In the autumn of 2022, an outbreak of ND was reported among pigeons (*Columba livia domestica*) in Oslo, Norway. It also spread to one commercial poultry farm (Silje Granstad et al. 2022). The winter and spring season of 2022-2023 increased contagion of ND with migratory birds returning to Norway. When this report is being finalized (February 2023) ND has caused a recent die off in several wild bird species in Rogaland, Telemark, Viken and Innlandet counties, showing a widespread outbreak of the more virulent strains (Mattilsynet.no 2023).

Other common viral respiratory diseases in European pheasants include sinusitis associated with *Mycoplasma gallisepticum, pasturella*, avian pneumovirus, and avian coronaviruses (Welchman et al. 2002), all WOAH and Norwegian notifiable diseases, and marble spleen disease which is not notifiable (Fitzgerald and Reed 1989). These infections have as far as we are aware not been found in Scandinavian pheasants or partridges.

Wiberg and & Gunnarsson (2009) reported gapeworm infections causing respiratory symptoms, and diarrhea as common herd morbidities among Swedish rearers. Anthelmintics were used routinely, and in some cases the broad-spectrum antibiotic tetracycline was additionally used prophylactically together with coccidiostats. This is a report from 2009, and this anti-microbial practice is outdated in 2023, with updated knowledge of antibiotic resistance. Diarrhea could possibly be caused by Rotavirus which is a common cause of diarrhea in young birds, and commonly found in pheasants and partridges, which develops immunity with age (Day 2020). Another possibility is infection with the protozoan disease coccidiosis, caused by the genus *Eimeria*, which commonly cause diarrhea in poultry productions and gamebird productions (Cervantes, McDougal, and Jenkins 2020). A study from Finland stated that chicks in their first week of life were provided with Terramycin in the water against microbial diseases (Liukkonen-Anttila et al. 2002), but once again we caution against old results which does not reflect the anti-microbial politics of 2023.

Salmonella infections in poultry can be classified into three categories: pullorum disease (caused by *Salmonella enterica* serovar Gallinarum biovar Pullorum), fowl typhoid (caused by *S. enterica* serovar Gallinarum biovar Gallinarum), and fowl paratyphiod (caused by other serovars) (Gast and Porter 2020). Pullorum disease and Fowl typhoid are both WOAH notifiable diseases, whereas fowl paratyphoid is listed as notifiable in several European countries, including Norway. The poultry paratyphoid *Salmonella* organisms, comprising more than 2000 serotypes, are a major problem to the poultry industry since these serotypes are prevalent in some broiler or layer hatcheries and houses and can cause human gastroenteritis (Barrow 2000). Although, the prevalence in Norway and other Nordic countries is low, estimated to 0.2% in Norwegian livestock populations in 2021 (Heier et al. 2022), and sporadic cases in the wildlife fauna of *S. typhimurium* which previously occurred in hedgehogs and passerine birds (HEIR et al. 2002). There are no recent reports of Salmonella in game birds, but it was documented in Great Britain in the 1990s (Pennycott and Duncan 1999)

Sporadic disease outbreaks can include a variety of different pathogens which *Galliform* birds are susceptible to, although none of these have been reported in Scandinavian gamebirds to our knowledge. An outbreak of avian encephalomyelitis in a pheasant farm was reported in Britain (Welchman et al. 2009). In France, a novel parvovirus (*Chaphamaparvovirus*) caused outbreakes of hepatitis in pheasants from rearing farms 2017 – 2021 (Matos et al. 2022). A study from Austria and Spain showed that released pheasants infected with *Eucoleus contortus* had higher risk of fox predation (Millán et al. 2002). Both pheasants and partridges are susceptible to blackhead disease, caused by the protozoan *Histomonas meleagridis*. This protozoan's life cycle is dependent on the caecal nematode *Heterakis gallinarum* (McDougald 2008). Although, being susceptible to a disease, and risk exposure for a disease in Scandinavian ecosystems is not necessarily the same. Diseases exclusively found in *Galliformes*, and not found in Norwegian wild or domesticated *Galliformes*, is unlikely to be introduced by migrating birds (*Galliformes* not being migrating birds).

- The epidemiological triangle describes the relationship between pathogens, animals and the environment. We limit discussion to pathogens, environments and animals that pertain to Europe since they are relevant to rearing and breeding of pheasant and partridge in Scandinavia.
- Between October 2020 and today (February 2023) we have experienced the largest epidemic of avian influenza (HPAI) ever recorded.
- Newcastle disease, an extremely contagious avian viral disease, have been recorded in pheasants in Great Britain, Denmark and in one Swedish pheasant but does not seem to be of high prevalence.
- Gapeworm infections and related morbidities have been common among Swedish rearers.
- Salmonella infections is a major problem to the poultry industry put has low prevalence in the Nordic countries.
- Diseases exclusively found in Galliformes, and not found in Norwegian wild or domesticated Galliformes, is unlikely to be introduced by migrating birds.

6.1.1 Assess the likelihood of introducing contaminants by importing breeding pheasants and partridges to Norway

Import of live birds needs to follow Norwegian legislation for import and transport (Anon 1999). This includes mandatory veterinary inspection of the birds, to decrease risk of importing contaminants. Pheasants and partridges are *Galliformes,* which are non-migrating birds with relatively low dispersal (Fuller and Garson 2000; G. R. Potts 2012). This means that movement of these birds could expose other *Galliformes* to species specific disease, they otherwise would not encounter naturally. Norway has previously imported both pheasants and partridges from neighbouring countries.

During the current outbreak of HPAI and ND, both of these diseases have been found in pheasants in Sweden (Grant et al. 2022) and HPAI have been found in pheasants in Finland (Finnish Food Authority 2022), and in Denmark (Danish Veterinary and Food Administration 2022). In years without major contagious outbreaks importing pheasants and/or partridges from neighbouring countries should not necessarily introduce contaminants if all preventative measures (intact hygiene in rearing flock, veterinary inspection of birds, transport in optimal containers) and rules and legislations for import of live poultry have been followed. However, during the current HPAI and ND outbreak, we would caution against import of pheasants and partridges. If import does take place we recommend testing for disease in advance (more on this in section 4.4), and a close dialogue with the Norwegian Food safety Authority.

- Importing galliformes could expose other galliformes to spices-specific disease they normally not would be exposed to.
- Veterinary inspection of birds will reduce risk of importing contaminants.

- Importing birds from Sweden in years without major contagious outbreaks will avoid the introduction of contaminants if preventative measures and rules and legislation for import of live poultry have been followed. We caution against importing birds during the current outbreak of HPAI and ND.

6.1.2 Assess the risk of spreading contagion between different flocks of pheasants and partridges in Norway, specifically considering moving live animals and eggs between flocks

To minimize risk of disease in game birds, appropriate livestock hygiene should be followed while the birds are in captivity. This means strict control and record-keeping of the health of birds entering a flock, preferably all in – all out regime, allowing for disinfection in-between herds. Avoid hatching eggs from external flocks into an existing flock (Defra 2010). In addition to being recommendations from the "Code of Practice for the Welfare of Gamebirds Reared for Sporting Purposes (2010)", these are common regulations for domestic poultry, and we recommend that breeders and rearers of pheasants and partridges follow these as well.

- Ensure disinfection between flocks
- Avoid hatching eggs from external flocks into existing flocks

6.1.3 Assess the risk of spreading contagion to wild birds from pheasant and partridge farms, specifically when animals are released into the wild in Norway

Several measures can be implemented to reduce the risk of spreading contagion to wild birds from pheasant and partridge farms. The "Code of Practice for Welfare of Gamebirds Reared for Sporting Purposes (2010)" reviews recommendations for disease prevention detailed from origin of stock, incubation and hatching, inspection and husbandry, food and water, management devices, housing and penning, disease treatment and record keeping, catching and transportation, and preparation for release (Defra 2010). In short, buildings should be protected from entry of wild birds and rodents as disease reservoirs. Biosecurity must be kept intact at the farm, for instance with disinfectant footbaths at all main entrances, or alternatively separate boots and coveralls for every person entering the building. Everyone entering the farm should wash their hands in soap, which means the entrance should additionally have a sink with hot water for hand washing. A record should be kept of all visitors of the building. Adequate ventilation and drainage are factors important to maintain a good and disease-free environment. To prevent stress and for good animal welfare, birds should also have at least 8 h of darkness during the night for resting and sleep. Birds should be checked on at least twice daily as required by Norwegian law (Anon 2016).

Aviaries (or cages for partridge families) should have double walls of mesh netting, to prevent direct contact between wild birds and game birds in captivity. They need to be spacious enough for all birds to fit under a sheltered area with an intact roof, and similarly for all birds to fit under the section with mesh net roof. All food and water should be fed under the sheltered section to avoid contact with wild birds.

All gamebird breeders and rearers need appropriate experience to recognize problems and should register with a veterinary practice and have regular flock controls to deal with possible problems with welfare, disease or injuries requiring attention. Any bird suffering from illness, poor health or injury must receive immediate attention, including veterinary care if needed. Medical treatment should only be used when needed and prescribed by an attending veterinarian. Expert advice should be sought whenever necessary. An emergency plan should be in place to deal with fire, flood, storm, damage of building, interruption of supplies or notifiable disease. We recommend keeping records for at least three years post release. These records help to identify problems with management, husbandry, health, and welfare, in addition to traceability for disease outbreaks. For transport and release, the same hygienic standard must be kept intact with full disinfection of boxes, transport containers, and vehicles between loads. Once birds are released the aviaries should be disinfected with calcium to avoid runoff from the farm to neighboring habitats.

Following these recommendations, in addition to the “soft release” regime, which reduces emotional and physical stress for the birds before the final release into the wild and thereby strengthens the bird’s physiology and immune system, will substantially reduce likelihood of introducing contagion to wild birds. Pheasants and partridges do not migrate, and have relatively low dispersal rates (Fuller and Garson 2000; G. Potts 2012), and in areas without disease outbreaks, they can be relatively safely released without introducing contagion to wild birds. It is also important to protect pheasants and partridges from virulent disease strains form wild birds. During the current outbreaks of HPAI and ND, several municipalities in Norway are under curfew/infected zone status for domesticated poultry due to circulating virulent strains of HPAI and ND in wild birds. It is not legal to release gamebirds in these areas (Anon 2022a). It is important to be in a close dialogue with the Norwegian Food Safety Authority about the development of the situation, and under no circumstance release birds into infected zones.

- Facilities should be protected from entry of wild birds and rodents as disease reservoirs
- Visitor management should incorporate biosecurity e.g. washing of hands, disinfection of boots and records of visitors.
- Aviaries or cages should have double walls of mesh netting to prevent contact with wild birds.
- Breeders need appropriate experience to recognize problems and have regular flock controls by a veterinary
- Applying to recommendations, rules and legislation coupled with “soft-release” regimes will substantially reduce the likelihood of introducing contagion to wild birds.

6.1.4 Assess risk reducing measures including testing before transport and release for spreading contagion between farms keeping pheasants and partridges to wild birds

The influenza viruses are members of the family *Orthomyxoviridae*. There are seven influenza genera but only influenza A viruses infect birds. Symptoms and incubation time can be variable, and range from decreased food intake, decreased egg production, lethargy to death, which means that screening only based on symptoms is poor veterinary practice (Swayne, Suarez, and Sims 2020). Instead laboratory testing should be instituted. For avian influenza, blood samples can be collected from the birds for serological screening for antibodies against influenza A. A competitive multispecies ELISA kit (ID Screen® Influenza A Antibody Competition, multispecies) is used in the Norwegian surveillance program for avian influenza in poultry to screen serum samples for antibodies against influenza A virus (Granstad, Fosse, and Åkersted 2023). This method does not discriminate between high pathogenic or low pathogenic influenza, and positive findings can be confirmed by the gold standard of HPAI testing where virus is isolated directly in chicken embryos and confirmed with the presence of haemagglutinating activity. Alternatively, initial diagnosis can be conducted by direct detection in oropharyngeal or cloacal swab samples of one or more segments of the influenza A genome using real-time real time-Polymerase Chain Reaction (RT-PCR) or other validated molecular techniques (WOAH 2022).

Newcastle disease is highly contagious and often severe disease, and can be mild, moderate or very virulent. The milder strains are very widespread but cause few disease outbreaks. Symptoms can be quite similar to avian influenza, and the two diseases can easily be mistaken for each other based on clinical presentation. Birds often present with respiratory disease, but depression, nervous manifestations, or diarrhea may be the predominant form (Suarez et al. 2020). There are ten serotypes of avian paramyxoviruses designated APMV-1 to APMV-10. Similar to diagnosing HPAI, ND can be diagnosed with oropharyngeal or cloacal swabs from live birds, inoculated into allantoic cavity of 9 to 11-day-old embryonating fowl eggs. Lastly all eggs are tested for haemagglutinating activity and/or by use of validated specific molecular methods. An alternative method is RT-PCR, or a serological screening using the haemagglutination inhibition test (WOAH 2018).

Serological screening of all pheasants and partridges before release holds the potential to drastically decrease risk of introducing contagion of HPAI or ND to wild populations from releasing captive gamebirds into the wild. The screening could additionally test for other diseases, and the assessment for necessary testing should be a dialogue with the local branch of the Norwegian Food safety Authority since the need for disease screening will vary both with time and location.

- Pre-release serological testing of birds can drastically reduce risk of introduction contagion of HPAI or ND to wild bird populations.

6.2 Conclusions

By literature review, this report assesses the ecological impacts and animal welfare aspects relating to the captive-breeding and release of peasant and partridge in Norway. The practice has been discontinued because applications for release were rejected. The rationale behind rejections was the risk of negative impacts on biodiversity and violations of the Animal Welfare Act.

Currently, no information supports the hypothesis that release practices of pheasants and partridges undertaken the last decade pose a threat to biodiversity or ecosystems in Norway. On the contrary, the general lack of focus on such issues in the European literature outside Great Britain speak to the opposite. The focus has rather been on how partridge and pheasant conservation and management entail secondary effects on the agroecosystems which are holistically positive from a conservation standpoint (Interreg North Sea Region 2023). Concerns of negative impacts from releases stem from UK-studies that have assessed impacts of annual releases averaging 47 million pheasants which is not comparable to Norwegian conditions. The annual average (2013-2020) released in Norway was 5638 pheasants and partridges combined.

The welfare of captive-bred pheasants and partridges in relation to their environmental conditions during captive-breeding has been insufficiently investigated. Stress-related behaviours can occur when certain conditions are not met. For instance, will increased space or environmental enrichments reduce feather-pecking. The degree to which this have been a problem among Norwegian breeders is unknown. With our current understanding of animal welfare, it is possible to conduct captive-breeding programs that do not jeopardize animal welfare and simultaneously minimize the risk of importing and spreading of contagion. Captive-breeding and release protocols that significantly improve the adaptiveness and post-release survival has also been developed and should be adopted if practices are continued. However, Norway has always been on the fringe of the distributions of pheasants and partridges in Europe and the prospects of pheasants and partridges establishing viable populations in Norwegian nature is probably low without aiding populations with legal predator control, habitat improvement and supplementary feeding in combination with optimized release techniques and breeding protocols.

Whereas the pheasant is a non-native species in Norway, the partridge is native and RE. Regarding regionally extinct (RE) species which have been reintroduced, as is the case for Norwegian partridge, IUCN states that the *"formerly RE taxa may be assessed as soon as at least a part of the population successfully reproduces without direct support and the offspring are shown to be viable"* (IUCN Species Survival Commission, 2012). Releasing of captive-bred individuals or translocation of wild individuals can be useful tools in re-establishing populations that have gone extinct in an area (IUCN/SSC, 2013). According to IUCN, releasing grey partridge into agricultural areas in Norway can be viewed as conservation work and initiatives focusing on improving the population status of partridge should be welcomed. Should release practices continue, we need scientific investigations that inform on population performances and animal welfare aspects under Norwegian conditions.

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Høgskolen
i Innlandet

Institutt for Skog- og Utmarksfag ved Høgskolen i Innlandet fikk i oppdrag av Fuglehundklubbenes Forbund (FKF) og deres Lavlandskomite (LK) om å gjennomgå og vurdere praksisen med utsetting av fasaner og rapphøns, og spesielt evaluere økosystemeffekter, effekter på biodiversitet, dyrevelferd under oppdrett, avl, transport og utsetting, og risiko for dyrehelse og sykdommer ved import, avl, oppdrett og utsetting av disse fuglene i norsk natur.

Økosystemeffektene av å øke populasjoner kunstig kan være positive, negative eller ubetydelige fra et bevaringsperspektiv. Negative effekter inkluderer endringer i artenes samhandling via ressursforbruk, agonistisk adferd eller predasjon. Disse formene for interaksjoner mellom arter forsterkes med økende antall fugler satt ut. Under ekstreme forhold har utsetting av fasan hatt negative effekter på vegetasjonsdekke og virvelløse dyr inne i og på utsiden av akklimatiseringshegn i Storbritannia, og i Storbritannia opprettholder utsatt fugl sannsynligvis også høye bestander av generalistpredatorer.

Positive effekter av utsetting inkluderer støttende forvaltningstiltak som tar sikte på å begrense faktorer som reduserer overlevelse og populasjonsvekst som rovdyrkontroll, tilleggsfôring og habitatforbedring. Disse faktorene er forutsetninger for vellykkede utsettingsprogrammer, og de kan bedre bevaringsstatusen til flere andre arter. På grunn av lav overlevelse og uforløst reproduktivt potensial, antyder populasjonssimuleringer at utsatt rapphøns og fasan i Norge trenger støttende forvaltningstiltak for å unngå utdøing.

Målet når man avler rapphøns og fasaner er å selektere for vill adferd, og dette krever ulike oppdrettsforhold sammenlignet med domestiserte arter. Kunnskapsgrunnlaget om oppdrettsforhold som oppfyller behovene til fasaner og rapphøns er imidlertid lavt. Å øke plassen og berike habitatene i oppdrettssystemene vil imidlertid redusere stressrelatert adferd. Oppdrettsforholdene bør tilnærme seg naturlige forhold når det gjelder kosthold, uregulert sosialitet mellom individer og muligheten for eksponering for naturlige stressorer. Forskjellige patogener er registrert blant fasaner i Skandinavia, og import fra utlandet kan eksponere norsk hønsefugl for artsspesifikke sykdommer de vanligvis ikke ville påtruffet. Flere tiltak kan iverksettes for å minimere risikoen for spredning av patogener. Disse inkluderer hygiene på oppdrettsanlegg, veterinærundersøkelser av fuglene før import, og sikre oppdrettsanlegg som hindrer kontakt med dyreliv utenfor.

Når man vurderer utilsiktede effekter på økosystemer etter utsetting av oppdrettede fugler, er det viktig å ta hensyn til omfanget og skalaen på utsettingen. Studier som fokuserer fauna- og flora-effekter har hva vi kjenner til kun blitt utført i Storbritannia, der 47 millioner fasaner slippes ut årlig. Det norske utsettingsprogrammet er forsvinnende lite i forhold, og det finnes for øyeblikket ingen informasjon som støtter hypotesen om at rapphøns og fasaner som er satt ut i Norge de siste ti årene, har hatt negative effekter på norske økosystemer eller det biologiske mangfoldet. Med nåværende forståelse av dyrevelferd, er det også mulig å tilpasse oppdretts- og utsettingsprogrammer som minimerer risikoen for spredning av patogener og som produserer sunne og levedyktige individer som er godt tilpasset livet utenfor oppdrettsanlegget.