

How scientific knowledge of geese-friendly methods to reduce geese damage in the Netherlands can be better implemented in policies and management plans

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Abbreviations

FMU Fauna Management Unit

FMP Fauna management Plan

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Nederlandse samenvatting

Ganzen populaties in Nederland groeien sinds de jaren '90. Zowel overwinterende en stand-ganzen populaties nemen toe, om verschillende redenen: intensivering van de landbouw, een lagere predatiedruk, de ontwikkeling van kleine natuurgebieden verspreid in het agrarische landschap en tenslotte, de klimaatverandering. Ganzen veroorzaken landbouwschade, voornamelijk een opbrengstverlies tijdens de eerste grasmaai in het voorjaar, maar ze kunnen ook wintergranen en andere gewassen beïnvloeden, zoals aardappelen en bieten. In 2005 werd een landelijk besluit genomen om ganzen te beheren door hen te verschikken naar specifieke rustgebieden in de winter, met als doel de landbouw schade door ganzen te verminderen. In 2012 kwam een einde aan deze aanpak, maar werd provinciaal op vergelijkbare wijze voortgezet. Het beheer bestaat uit winterrust met uitzondering van kwetsbare gewassen, waar jacht wel kan plaatsvinden en het inzetten op een flinke reductie van voornamelijk de aantallen stand-grauwe ganzen (de meest problematische soort) tot ongeveer 1/3 van zijn werkelijke grootte. Dit doet men door middel van nestbehandeling, jacht en vergassing in sommige provincies. Anno 2015 waren de ganzenpopulaties nog steeds in een groeifase en de financiële compensatie in de landbouw bereikte een niveau van 16 miljoen euro, waarvan 10 miljoen werd veroorzaakt in de winter.

Wanneer een wild dier in conflict is met de maatschappij, worden dodingsmethoden vaak gekozen omdat het doden als een snelle en effectieve oplossing beschouwd wordt. Deze methode moet vaak herhaald worden als de oorzaak van het probleem niet opgelost is, en heeft daarnaast als nadeel dat het een hoog potentieel heeft om pijn bij dieren veroorzaken. Het huidige ganzenbeheer in Nederland toont dan ook weinig respect voor het welzijn van dieren, omdat jacht en vergassing hoge hoeveelheid pijn kunnen veroorzaken. Diervriendelijkere maatregelen die effectief zijn om ganzenschade te beperken, lijken nauwelijks structureel te worden ingezet in het beheer. De Dierenbescherming heeft daarom opdracht gegeven aan Sonia Van Wijk om een onderzoek uit te voeren naar of en op welke manier wetenschappelijke kennis over effectieve diervriendelijke methoden wordt gebruikt in het Nederlandse (provinciale) beleid en uitvoering. Dit werd gedaan door:

- 1- Een samenvatting van de wetenschappelijke literatuur, het provinciale natuurbeleid en ganzenbeheersplannen maken;
- 2- Onderzoekers, provinciale beleidsmakers en faunabeheerders interviewen;
- 3- Een enquête onder provinciale statenleden houden.

Uit het beschikbare onderzoek wordt geconcludeerd dat de Nederlandse ganzenbeheer meer rekening kan houden met het welzijn van dieren, terwijl tegelijkertijd ook de ganzenpopulaties/schade kan verminderen. Om dit te bereiken is het noodzakelijk om de volgende methoden, die wetenschappelijk bewezen effectief zijn om ganzen te beheren in beleid en uitvoering in te zetten: matigen van de vossenjacht, verbossing of het installeren van rasters in ganzen broedgebieden, alsmede een intensiever verjaging naar goed gelegen rustgebieden voor stand(zomer) en winterganzen. Terwijl het provinciale beleid geen wetenschappelijke bronnen gebruikt, gebruiken faunabeheereenheden deze vooral om in

hun faunabeheerplannen het gebruik van alternatieve methoden te ontmoedigen. Dit doen zij door te benadrukken dat de effectiviteit slecht is (met "verplaatsing naar de buurman" effect, hogere kosten, weinig kansen om de gewenste aantal te bereiken en opkomst van andere problemen als hoofdargumenten).

In het algemeen denken onderzoekers dat het belangrijkste punt om het ganzenbeheer te verbeteren is om een betere coördinatie van verjaging te organiseren en om rustgebieden in te stellen. Deze coördinatie op verjaging/jacht en het instellen van rustgebieden zou provinciegrensoverschrijdend moeten gebeuren, omdat ganzen geen grenzen kennen. Beleidsmakers en faunabeheerders geven prioriteit aan een snelle reductie van de ganzenpopulatie door de dodingsmaatregelen, en zij geven aan dat alternatieven pas toepasbaar en uitgevoerd kunnen worden nadat het doel van het reduceren van zomerganzen populaties bereikt is. Provinciale statenleden staan gunstig tegenover diervriendelijkere maatregelen en tonen een bereidheid om in deze te investeren.

De grootste belemmering voor het bereiken van een diervriendelijke ganzenbeheer is het weinige vertrouwen dat het probleem daarmee kan opgelost worden en de mogelijk hoge uitvoeringskosten. Als eerste stap is het aan te raden om een pilot te doen in een provincie waar een intensiever gecoördineerde verjaging uitgevoerd wordt (met betaalde krachten en nieuwe veelbelovende verjagingstechnieken zoals lasers en drones), en de kosten en baten van de deze aanpak te evalueren. En indien succesvol, deze uit te breiden naar de andere provincies. Bovendien moet de installatie van rasters rondom broedgebieden veel groter zijn omdat de wetenschap aantoont dat dit wel degelijk tot minder ganzen leidt en omdat het makkelijk uitvoerbaar is, omdat zowel het landschap als de landbouw niet drastisch hoeven te veranderen. Tot slot, in de huidige context van sterke jachtdruk op grote schaal op zomerganzen, is de noodzaak om meer reservaten bepalen zonder verstoring voor zomerganzen cruciaal. Zonder deze rustgebieden blijven zomerganzen gebruik maken van agrarisch grondgebied, voor rust en eten.

Summary

Geese populations in the Netherlands are expanding since the 90's. Both wintering and resident populations are increasing, for multiple reasons: agricultural intensification, a lower predation pressure, the development of small natural areas dispersed in the agricultural landscape and finally climate change. Geese cause agricultural damage, consisting mostly of yield loss during the first grass cut in spring, but they can also affect winter grains cultures and other cultures like potatoes and beets. Since 2005, nationally and from 2014 onwards at provincial level wintering geese are managed by providing them resting areas in nature and in agricultural fields, while outside these fields scaring and possibly hunting activities can be undertaken. In 2015, geese populations were still in the growing phase and agricultural monetary compensation reached 16 million euros, of which 10 million is winter damage. Since the management has been decentralized to provinces in 2012, the aim is to reduce resident greylag geese populations (the most problematic resident species) in summer, to roughly 1/3 of its actual size through hunting, gassing in some provinces, and egg shaking.

When a wild animal is in conflict with the human society, one often chooses to kill the animal because it can be viewed as a fast answer. However, this method often has to be repeated again and again if the root of the problem is not solved. Besides the fact that it does not solve the problem, it also has a high potential for causing pain to animals. The actual geese management in the Netherlands is viewed as not respecting animal welfare because hunt and gassing can cause high amounts of pain. Scientifically proven effective alternatives to killing are present, however, the implementation of these methods in policy and management plans seem to be mostly lacking. De Dierenbescherming has therefore mandated Sonia Van Wijk to perform research on if and how scientific evidence of animal-friendly methods are used in the Dutch policies and management. This was done by:

- 1- Summarizing the scientific literature, Dutch nature policies and geese management plans
- 2- Interviewing researchers, policymakers and fauna managers
- 3- Surveying provincial deputies

From the available research, it is concluded that the Dutch geese management can gain in animal welfare while also reducing geese populations or damage. Promising scientifically proven effective methods include: restraining fox hunting, reforestation or installing fences in geese breeding areas as well as a more intense scaring of geese towards well-situated resting areas. While provincial policies do not use scientific evidence, management plans mostly use it in a way to discourage the use of alternative methods by underlining the relative poor efficiency. They refer to them in terms as: "displacement to the neighbor" effect, higher costs, few chances to reach the desired population level and emergence of other problems.

In general, researchers think that the most important point to improve geese management is to make a better coordination of scaring to resting areas between provinces because geese know no borders. Policymakers and fauna managers give priority to the reduction of geese population more rapidly through death measures, and therefore see alternatives implemented after that the goal is reached. Provincial deputies are favorable for animal-friendly measures and present a willingness to invest in it.

The greatest barriers to achieving an animal-friendly geese management is that there is little confidence that the problem will be solved and that the implementation costs are high. To gain confidence, it is recommended to do a pilot in one province where a more intense and coordinated scaring is performed (with a payed team using new promising scaring techniques like lasers and drones), evaluate the costs and benefits of the approach and if successful, extend it to the other provinces. Moreover, the installation of fences around breeding areas should be much greater because science shows its effectiveness and because both the landscape and the type of agriculture do not need to be profoundly changed. Finally, in a context of strong hunting pressure on a large scale, the need to determine more sanctuaries without disturbance for resident geese is crucial.

1. Introduction

Geese biology

There are around twenty species of geese in the world (Madge and Burn, 1988), generally all obligate herbivores and migratory birds (Owen, 1980), but all varying in their behavior (migration, feeding or breeding behavior). One of the important drivers of their migration to the arctic during spring is their evolutionary history: They colonized northern regions that became multiple times inhospitable during the Pleistocene glaciations. That promoted the ability of birds to move elsewhere during these inhospitable periods, therefore, to migrate (Berthold et al., 2013). Presence of predators in the habitat is thought to promote strong bird avoidance to certain migration trajectories (Ydenberg et al., 2007) and also breeding grounds (Alerstam and Högstedt, 1982). The low presence of predators in the arctic allowing to breed safely can therefore promote the retention of this migration behavior. It is acknowledged that before human began to transform wetlands into agricultural fields, geese and other waders used these wetlands as important stop-overs of migration (i.e.: places to stop during migration to recuperate). Geese usually synchronize the timing of their migration with the emergence of marsh plants in spring (Bauer et al., 2008; Van Eerden et al., 2005). The use of these newly-grown plants gives them an important source of proteins thought to be necessary for a successful migration and reproduction success (Fox et al., 2016). Wetlands are important for geese not only for food provisioning and roosting during migration, but also because they present a safe habitat for molting geese (water acting as a barrier against land predators) (Alerstam and Högstedt, 1982).



Figure 1 Barnacle geese breeding in Svalbard, a Norwegian archipelago in the Arctic

Human impact on migrating geese

Around the world, the recent increase of geese populations during the last 50 years are thought to be due to a combination of factors including a shift of geese foraging from marshes to the now highly fertilized agricultural fields, a decrease in human hunting pressures and an increasing area of stop-overs with successful nature policies (Amano et al., 2004; Ebbinge, 1991; Van Eerden et al., 2005; Gauthier et al., 2005; Owen, 1990). The Netherlands being particularly attractive for geese with the highly-fertilized grasslands combined with easy access to water, has led to an increase of the geese populations using the Netherlands as a migratory stop-over as well as a wintering ground (Figure 2, Netwerk Ecologische Monitoring, 2015, Van Eerden et al. 2005). Increasingly warmer winters has also led to more greylag geese establishing their winter quarters in the Netherlands instead of using the country as a stop-over of migration only (Ramo et al., 2015). It represent an estimation total amount 2,1 million migrating and wintering geese in the Netherlands (SOVON, 2013).

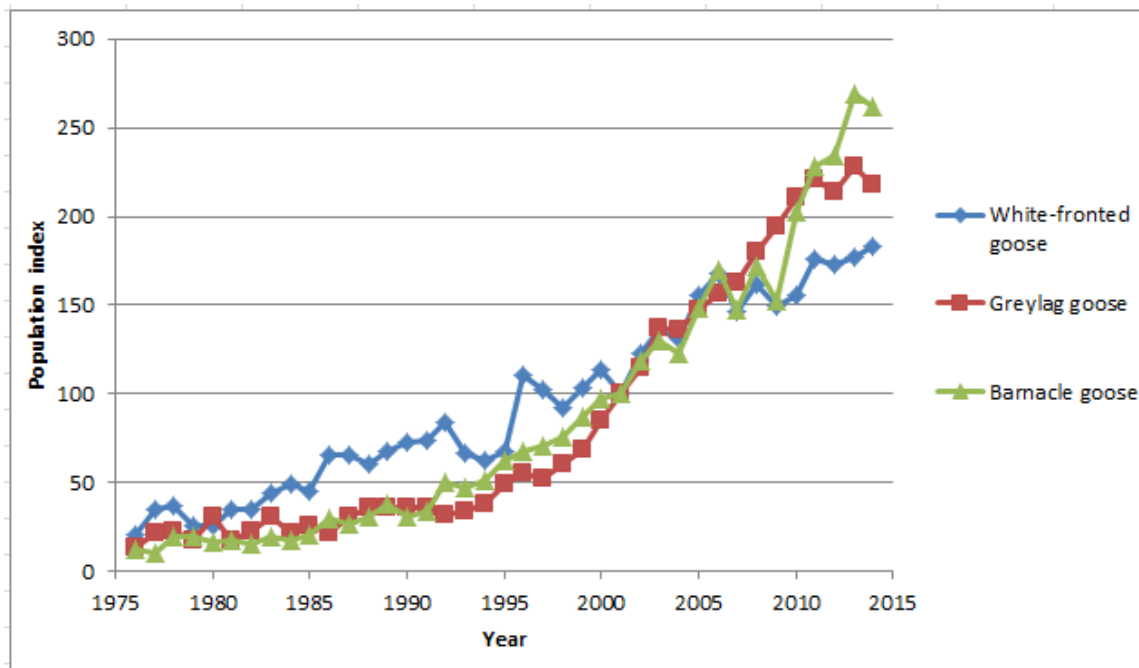


Figure 2 Index from the migrating and wintering population of white-fronted, greylag and barnacle geese, from 1975 to 2014 (Netwerk Ecologische Monitoring, 2014). The index is a relative quantity and was developed by SOVON (Teunissen 2002).

Human impact on resident geese

Not only did the wintering geese population increase, also the resident geese population (Figure 3, Netwerk Ecologische Monitoring, 2015) increased in number, to an actual estimate of 600 000 geese (KNJV, 2016; SOVON, 2013). Resident geese are geese breeding in the Netherlands and mostly consist of the greylag goose (van der Jeugd et al., 2006). This population went quasi-extinct and recovered thanks to reintroductions in the 1960s combined with dispersion from other countries' populations (van der Jeugd et al., 2006; Lensink et al., 2013). To a lesser extent, resident populations of other goose species are also growing: the barnacle goose, the white-fronted goose (both established in the 1980s), the Canada goose (mostly introduced in Europe 200 years ago for game hunting) and the naturalised domestic goose (van

der Jeugd et al., 2006; Jonker et al., 2013). For these populations, the high growth observed is linked not only to the higher food availability and lower hunting pressure, but also to the high breeding success possible in the country via:

- Safe breeding and molting areas available (wetlands, islands, low predator presence);
- Presence of agricultural fields near the breeding habitat for chicks to feed on (van der Jeugd et al., 2006).

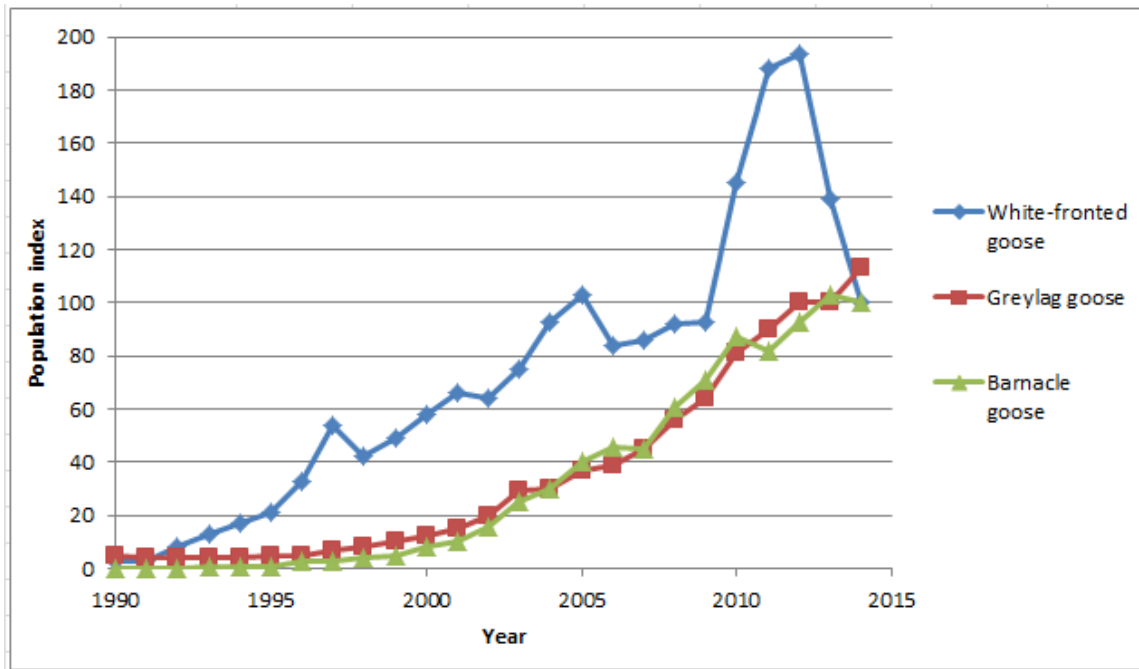


Figure 3 Abundance index of the resident population of barnacle geese, greylag geese and white-fronted geese, from 1990 to 2014 (Netwerk Ecologische Monitoring, 2014). The index is a relative quantity and was developed by SOVON (Teunissen 2002).

Evolution of geese damage and management in the Netherlands

Beginning of geese damage

Complaints by farmer yield loss by geese have been present in the Netherlands since the start of winter geese population growth, which happened before the start of resident geese population growth: Dutch government have compensated winter geese damage from 5000 guilders in 1974 to 1.5 million guilders in 1984, while the overall amount of winter geese went from 100 000 in 1960 to 600 000 in 1984. This also coincided with improved farm productivity with increasing fertilizers use and a reduction of the unproductive winter period's duration (Groot Bruinderink, 1989). Compensation as well as geese population steadily continued to increase since. Important changes in the following years consist in the geese hunting ban in 1999 following the pressure from Bird Protection Netherlands (*Vogelbescherming Nederland*) who wanted an approach using geese foraging areas (Vogelbescherming Nederland, 2010)

Implementation of foraging areas program

The responsibility for fauna management was diverted to the provinces since the introduction of the National “Flora and Fauna law” in 2002, whereas the damage compensation payments were still in hands of the National government (this is, as of 2015 also diverted to the provinces). Together (provinces and the National government) they introduced a National geese management approach in 2005. It was called the “winter foraging areas program”. It consisted in delimited foraging areas where a farmer would decide voluntarily to participate and would care for safety and good food availability for geese during winter and in turn, would receive a complete damage compensation. A farmer that did not participate would receive a compensation only if he performed scaring activities, including scaring by hunting. The idea was thus to concentrate geese feeding on these foraging areas which would therefore limit the number of farmers affected by damage and ultimately the total amount the government would have to pay for geese. The goal was to have 80 000 ha foraging areas (this includes 14.000 ha of foraging areas in geese designated nature conservation sites) which was calculated to be able to contain the whole geese population (Figure 4). In the meantime, hunt was allowed again, in order to support scaring activities to limit damages (Directie Kennis, 2009; Vogelbescherming Nederland, 2010).

In 2009 until 2012, thorough evaluations of the foraging areas program were performed (van der Jeugd et al., 2008; Schekkerman et al., 2013). The conclusions were more or less the same: The goal of concentrating geese was not reached, with a relative stable 60% of wintering geese inside foraging areas. However, the determination of foraging areas in places where geese historically were concentrated worked, because foraging areas located in agricultural fields account for 3% of all agricultural area in the Netherlands (Beukema, 2013). In the meantime, the national geese monetary compensation kept increasing (Figure 5). Researchers had three main explanations for the absence of geese concentration:

- 1) The number of wintering geese have increased since the beginning of the program;
- 2) The scaring activities outside the foraging areas were not enough for a concentration;
- 3) There were not enough foraging areas, or they were situated in non-optimal locations in some provinces.

Two other factors may also have played a role:

- In some foraging areas, the so-called white dots (*witte vlekken*) were present : farmers with land within the suitable foraging areas, but who did not agree to let geese forage on their land – so they still scared geese and disturbed basically within the foraging area;
- Other activities within the foraging areas remained: farming/hunting other animals – so the areas where not always ‘safe’ from the geese perspective.

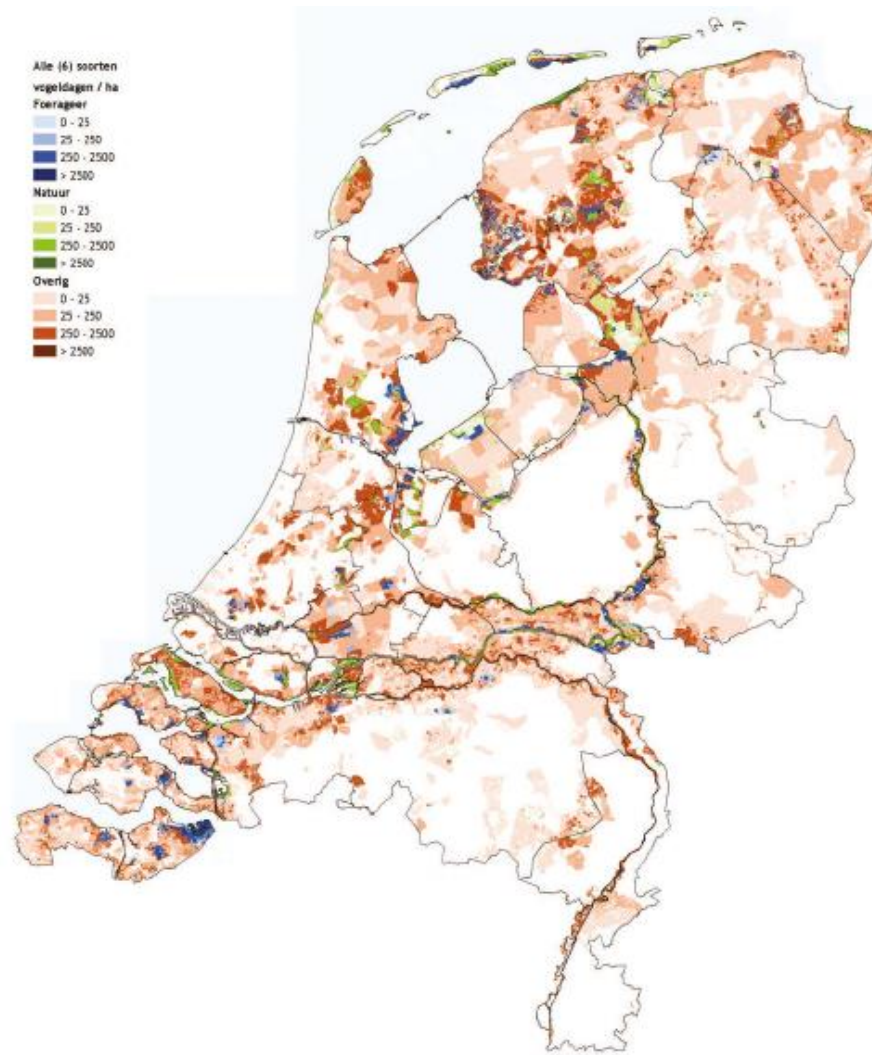


Figure 4 Presence of geese species in the Netherlands in relation to winter foraging areas. Blue: foraging areas. Green: Nature areas. Red: Other field use. 6 species were used: greylag geese, white-fronted geese, barnacle geese, Brent geese, taiga and tundra bean geese. The darker the color, the higher geese presence which is quantified in goose-days where a conversion factor is used to control for difference in species' energy needs (Hornman and Winden, 2013).

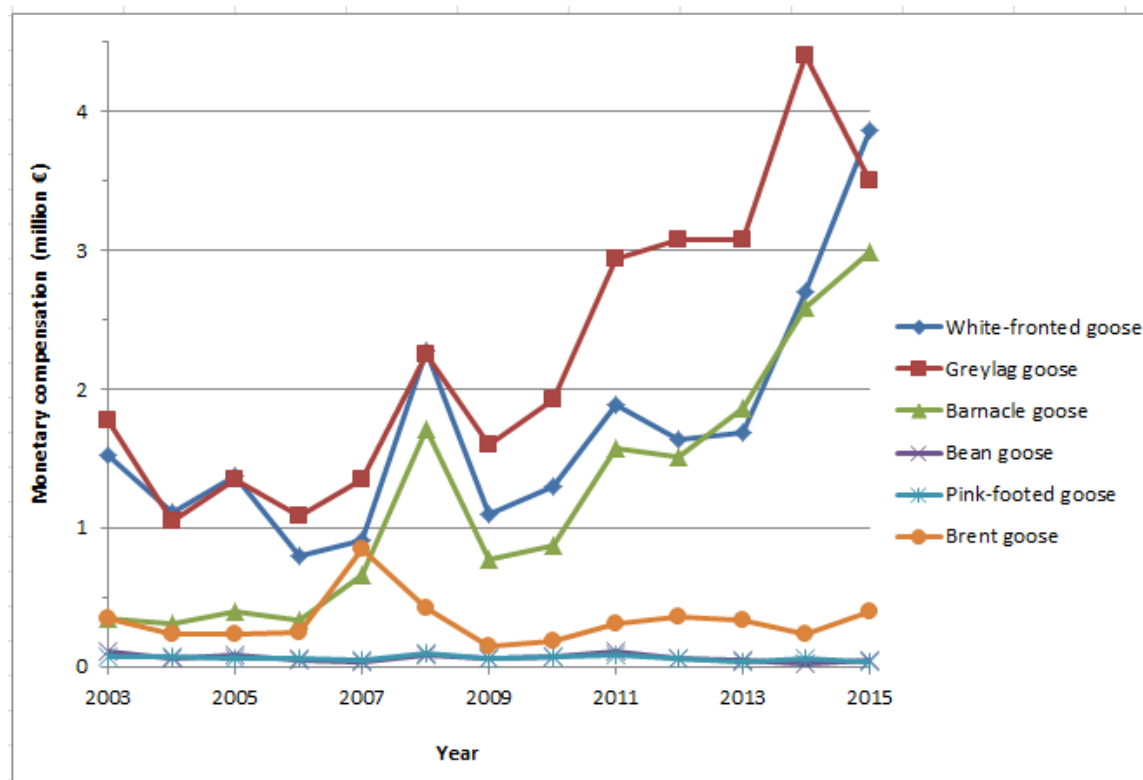


Figure 5 Monetary compensation for migrating and wintering geese in the Netherlands, 2003-2015 (Faunafonds, 2015). Importantly, annual fluctuations are in part due to the market price of agricultural products (Faunafonds, 2014).

The geese agreement negotiations and current management

In 2012, while monetary compensation still increased not only in winter (Figure 5) but since 2006 also during summer (Figure 6), Bird Protection Netherlands tried to build a new national approach. The new National approach was called the geese agreement (*Ganzenakkoord*) that would have been the result of an agreement among the designated important stakeholders including nature and landscape protection organisations, one farmer organisation, Bird Protection Netherlands and one landowner organisation. Although hunters were part of the initial negotiations, they left early in the process as they judged the policy “ethically and practically unrealizable” (Bakker, 2013). Towards the end of the negotiations on the agreement, farmers, Bird Protection Netherlands and the 12 provinces who are responsible for fauna management, made the compromise that a reduction of the resident population of greylag geese to the damage level of 2005 (via hunting and gassing) would be accepted if the winter “peace” was kept, i.e.: no hunt during winter, with few exceptions. The idea being that protecting migratory geese being of more importance than the protection of resident geese (migratory geese more prone to other threats – the protection of resident birds more in ‘our hands’). The geese agreement was finally never approved, as the farmer organisation left not long before the agreement would have come to life. The result is therefore a decentralisation of geese management to the 12 provinces, which is generally based on the geese agreement that never came to life (Bakker, 2013).

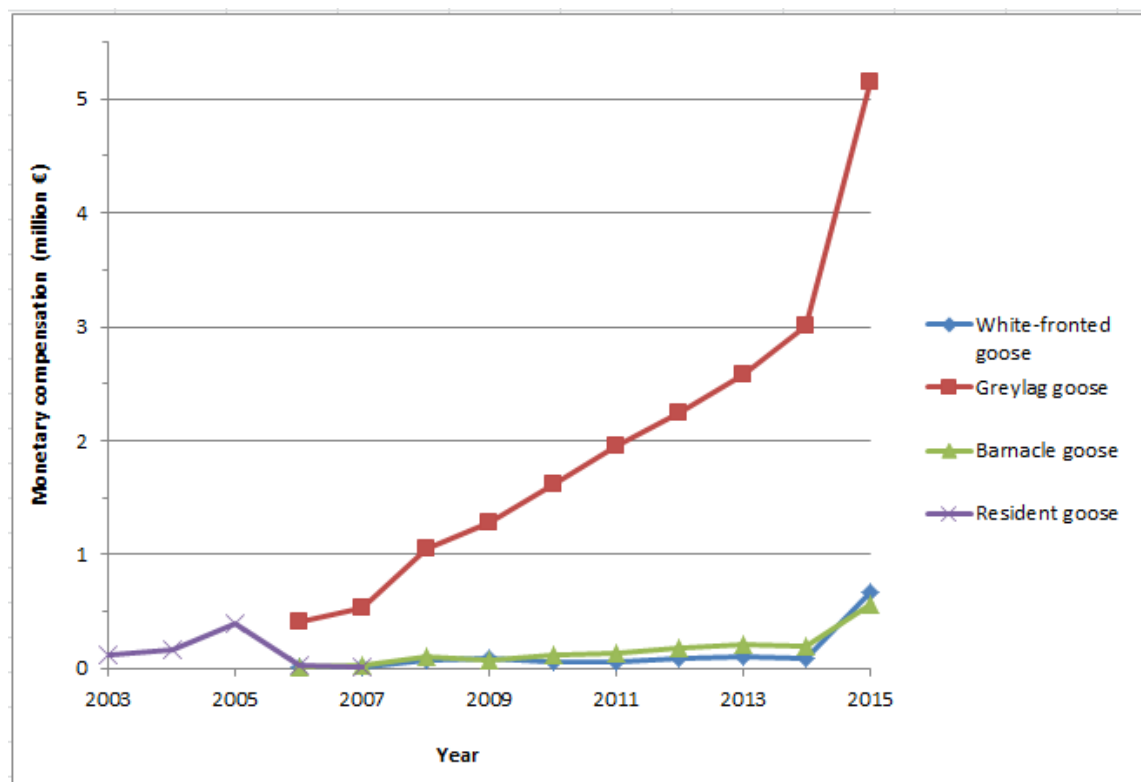


Figure 6 Monetary compensation for summer geese in the Netherlands : greylag geese, barnacle geese and white-fronted geese, 2003-2015 (Faunafonds, 2015). The category “Resident geese” includes the three in 2003-2005. Importantly to note that the damage caused by other summer geese species like the Egyptian goose and the domestic goose is not compensated because they are not protected indigenous species (with the exception of Canada geese for which no compensation are given even though it has the protected status) (Faunafonds, 2009).

An added tool to assist the reduction of the resident geese population: Gassing

In spring 2015, the European commission gave permission to use CO₂ (gassing) to kill pest animals (Kropman, 2015). Previous to this permission this method was only allowed for killing geese to increase plane safety at Schiphol Airport. The gassing method consist of putting a fence around molting geese (who are therefore not able to fly, Figure 7) near waterbodies in the summer, packing 250-500 geese in a chamber where the air is filled with CO₂. This has been reported leading greylag geese to the unconscious-state within one minute (Anonymus, 2010) and was judged relatively animal-friendly by the Dutch Animal Matters Council (RAD; Raad voor Dierenaangelegenheden 2012). Some provinces used this method for population reduction in the summer of 2015 and 2016. In summer 2016, the prohibition of using fences for capturing geese in the Dutch nature law formulation allowed the organisation Fauna Protection (*de Faunabescherming*), an animal-advocacy group, to make



Figure 7 Geese capture for subsequent gassing, Netherlands.

gassing activities stop. The reformulation of the *fauna- en flora wet*, which should be effective in January 1, 2017, should allow this method to be implemented again in summer 2017 (Volkskrant, 2016).

The wish of Dierenbescherming to have a more respectful management

At the same time that the geese conflict with humans increase, the Dutch people increasingly value the life of an animal and are decreasingly inclined of accepting the death of an animal because of damage to the human society (Sijtsma et al., 2012). There is indeed a shift in Western societies from materialism orientation (wildlife as an object for human use) to mutualism orientation (wildlife as having the same rights as humans), and in the Netherlands the latter is predominant (Jacobs, 2007). Reflecting this phenomenon, in 2006, the Party for the Animals obtained 2 seats on 150 in the Dutch parliament, the first case worldwide.

Dierenbescherming (Animal Protection Netherlands) is the biggest Dutch non-profit organization which aims at improving animal welfare. With 183 356 members, it is also the fifth biggest “green organization” in the Netherlands after WWF, *Natuurmonumenten*, Greenpeace and de 12Landschappen (Vroege vogels, 2015). The starting point of *Dierenbescherming* is the intrinsic value of an animal: Every animal has the right to live, experience and feel independently of the function it has for humans. Animal welfare in the sense of *Dierenbescherming* is “the quality of life perceived by the animal itself”, or the fact that an animal is able to perform its natural behavior (van Gerwen et al., 2015). Animal welfare is very different between animals whose lives depend on human society (pet, cattle, zoo) and animals independent of them, i.e.: wild animals. We have a high responsibility for animal welfare in the case of dependent animals: being a direct service for human society, they deserve equally as us humans, to not endure hunger, thirst, illnesses and stress.



Figure 8 A fox trying to capture a Canada Goose, UK.

There is an important distinction in wild animals: being independent of humans, they are evolving in nature, and this process implies that an animal can regularly experience hunger, thirst, illnesses and stress when expressing their natural behavior (Figure 8). In order to assess its welfare one can measure the degree to which animals are able to react to these stressors (ability to migrate freely/hide against cold etc., Ohl and van der Staay, 2012)

In the case of the actual geese management in the Netherlands, it has been decided that geese are too costly for the Dutch society (in terms of agricultural and recreational damage for example) in comparison to the benefits they give (by being an enjoyable feature in the landscape). The solution chosen to reduce geese cost to society seem to be in great majority hunting and gassing. However, the *Dierenbescherming* judge that hunting and gassing are not animal-friendly methods. It has been estimated that in hunted

populations of geese and swans, between 13 and 23% of living individuals are carrying at least one pellet in their body (from estimates not older than 2000 in barnacle goose (Denmark, Holm and Madsen 2013), pink-footed goose (Denmark, Noer et al. 2007), whooper and Bewick swan (UK, Newth et al. 2011)). The ratio 1:1, i.e.: for every killed individual, one receives one pellet and survives, is thought to be a reasonable estimate in hunted populations (Noer et al., 2007). While the majority of wounded individuals bear less than two pellets in general, the most extreme cases reported are a Bewick swan in 1991 with 30 pellets, and a whooper swan with 11 pellets in 2007 (Newth et al., 2011). Finally, while gassing has been judged relatively animal-friendly by the Animal Matters council given the fast reach of the unconscious state (Raad voor Dierenaangelegenheden, 2012), no quantification of stress experienced by geese based on behavioral indicators have been performed. Therefore, as long as it is unknown if the technique is acceptable on welfare grounds, gassing with CO₂ should not be performed (European Food Safety Authority, 2006).

Because of the negative impact of hunting and gassing on the welfare of animals, the *Dierenbescherming* does not advocate these types of management tools and calls for tools that would respect animal welfare. They know such alternatives exist, but have the impression that these alternatives are not fully explored and implemented in an effective way by policymakers (provinces) and those who coordinate the geese management (Fauna Management Units – which are land users such as hunters, farmers and nature conservation trusts). This even though they say they do (Dutch law also states that lethal methods can only be used if alternatives are not at hand) and that lethal methods are necessary because alternatives are not effective enough. As said, the *Dierenbescherming* believes the alternative, animal friendly approach can be expanded and that the current leading province policy, the reduction of the resident population, is not necessary in such an extent if alternatives are implemented more strictly.

Besides the fact that hunting and gassing geese imply pain and stress to the animal, the *Dierenbescherming* further uses as argument for a humane approach, that humans are the direct cause of geese exponential population growth with the increase in farming productivity, the creation of natural habitats, the relative safety of the Netherlands for geese with low predator presence like the fox and water predominance, and ultimately climate change. This growth being *dependent* on human society, humans are thus responsible for a more humane way to deal with the damage that geese cause.

2. Objectives

In order to investigate whether the impression of the *Dierenbescherming*, that scientifically proven effective methods to reduce geese damage in a more humane way (less disturbance and preferably non-lethal) are not implemented in provincial policies and fauna management plans in the most effective way, the following steps were taken:

- 1) Verification of the **scientific support** on the effectivity of the alternatives present and absent from the management.
- 2) Examination of **whether and how alternatives to hunting and gassing are implemented** in the provincial policies and fauna management plans

- 3) With the input of interviews with researchers, policymakers and fauna managers, as well as a survey to provincial deputies, **recommendations** were made to provinces, BIJ12, nature managers, the *Dierenbescherming* and farmers.

3. Method

The tools used for the purpose of the report are :

- 1) The scientific literature (scientific articles and reports from scientific Dutch entities, principally SOVON, Alterra and CLM) on geese damage and management alternatives to hunt and gassing.
- 2) the provincial nature policies (*natuurbeleidsnota*) and the Geese management plan from the Fauna management Unit (hereafter referred to as FMU) of each provinces where more detail is given over which methods are implemented
- 3) Interviews with researchers, policymakers and secretaries from FMU.
- 4) Survey sent to all provincial deputies that have been assigned to policies related to nature aspects.

4. Results

Scientific support

A non-exhaustive literature review of the scientific grounds of alternative methods to hunting and gassing are summarized in Table 1. In the column “Effectiveness”, an assessment is made on whether these measures can be used at a large scale for controlling geese breeding or damage. The measures present in the scientific literature that can be effective at a large scale for reducing geese breeding success are:

- Modifying nature and city park management with fewer islands and less grazing leading to vegetation succession.
- Predation by the fox
- Changing agricultural practices for an overall lower food availability (optimizing/lowering fertilization)

Measures that can be effective at a large-scale but requires yearly human interventions are:

- Fences or biodiesel agriculture surrounding breeding habitats
- Nest handling
- Paid coordinated scaring with well-situated winter foraging areas, possibly with attractive crops

The measures that are less suitable for a large-scale implementation, but are more adapted for sensitive situations are:

- Contraceptives
- Add repellency substances on fields
- Overhead wire grids on small waterbodies

Table 1 Scientific evidence for alternative measures worldwide in 2016 including reports from Dutch scientific institutes and consultants. Evidence is divided according to the type of effect (limit reproduction, access to water, feeding), the exact measure, goose species studied and location. Reference includes the source reliability (in order of reliability: peer-reviewed, proceedings, report). Peer-reviewed are articles published in scientific journal where peers of the scientific community revise the manuscript. Proceedings are articles from a scientific conference where the content has been reviewed by the conference committee. Reports are Dutch reports from scientific institutes, consultants or nature associations (example: Sovon, Alterra, Bureau Waardenburg, Natuurmonumenten) commissioned by governmental entities (ex: Faunafonds, Ministries, Provinces). In cases of a report, in parenthesis are presented first the research group, followed by the commissioner of the research, followed by the author of the report. Last column “Applicability” contains the answer to the questions: 1) can this measure be used at large-scale for controlling the population/damage? 2) In which context is this measure applicable 3) Is more research useful, and if so, why and how?

Effect	Measure	Goose species	Location	Findings	Reference	Applicability (1=large scale, 2=in which context, 3=more research useful)
Limits reproduction	contraceptives	Canada	USA	Diacazon has a long-term effect (months) and is costly. Raises health issues for other animal species that would ingest the substance	Proceedings (Fagerstone et al., 2006)	1) No 2) Urban context 3) Yes, no data for Dutch populations. Perform a pilot in the Netherlands
		Canada	USA	Nicarbazine has a short-term effect (must be baited daily) It has a 36-51% reduction in hatchability Environmentally-friendly	Proceeding, Peer-reviewed (Bynum et al., 2005, 2007)	
		Canada	USA	Commercial failure of Nicarbazine is due to: protected status of the species, the hunter lobby and the need to reduce the population is not accomplished by this (long-term effect).	Peer-reviewed (MacDonald and Wolf, 2013)	
	predation	greylag	NL, Gelderse Poort	Reduction of hatching success (~10% where fox is present vs >40% where fox is not present) Islands in deep water are more difficult to access by fox Population model with fox presence predicts stable to decreasing population Increase in meadow bird eggs predation after geese breeding period (opportunistic behavior of the fox). Possibly that meadow birds are protected from the fox during geese breeding period	Report (Sovon; Faunafonds) (Voslamber et al., 2012)	1) Yes 2) Throughout the Netherlands, except sensitive meadow birds areas 3) Yes, more thorough study on fox impact on geese and meadow birds is needed
		greylag	Denmark	Feeding areas close to molting site are chosen because of predator-avoidance behavior	Peer-reviewed (Kahlert, 2003)	
nest handling	greylag	NL, Texel	57 to 70% eggs were handled on Texel island. This reduced but not stopped the population growth	Report (Alterra; Faunafonds) (Kleijn et al.,	1) Yes 2) Urban context 3) No	

					2012)	
		greylag	NL, Sweden	Population model from 2 different populations show that 70% and 88% of all eggs must be handled for a population stabilization	Peer-reviewed (Klok et al., 2010)	
Limits reproduction	Landscape in nature reserves/city parks	greylag	NL, Gelderse Poort	Islands in deep water are more difficult to access by fox	Report (Sovon; Faunafonds) (Voslamber et al., 2012)	1) Yes 2) Nature reserves/urban parks 3) No
		greylag	NL, Oostvaardersplassen Lauwersmeer	Grazing by cattle and horse promote grazing by geese (facilitation) by shifting vegetation succession	Peer-reviewed (Vulink et al., 2010)	
		barnacle, brent	NL, Wadden Sea	Grazing by cattle and sheep promote grazing by geese (facilitation) by shifting vegetation succession	Peer-reviewed (Bos et al., 2005)	
		greylag	NL	Letting natural reserves develop to their final succession state decreases habitat suitability for geese, particularly small nature reserves dispersed in a agricultural landscape	Report (Sovon, Universiteit Groningen; Ministerie LNV) (van der Jeugd et al., 2006)	
	fences	greylag	NL, De Deelen	Reduction from 58% to 18-19% fledging rate The fence itself caused 0.5% of chick death by being stuck in it Fences were 50 cm high, best in metal to avoid holes by rabbits and geese escaping	Report (Sovon; Faunafonds & Friesland) (Voslamber, 2010)	1) Yes 2) Nature reserves 3) No; however, long-term monitoring of geese presence is areas with fences needed
		greylag	NL, Axelse kreek	29% fledging compared to 52% in a place near the study without fences	Report (Sovon; Zeeland) (Voslamber, 2007)	
		greylag	NL, de Wieden	Geese use of agricultural fields decreased from 75% to 10% the first year of implementation, and 5 years later it was 30%.	Report (Natuurmonumenten; Faunafonds) (Brandsma, 2012)	

		greylag Canada Egyptian	NL, APL- Polder	Fences maintained geese families inside the area Sheep fences let chicks of less than 5 weeks old outside	Report (Ministry; Bureau Waardenburg) (Boudewijn et al., 2009)	
Limits access to water	landscape	Canada	USA	Overhead wire grids deter almost all geese (between 75 and 100%) from using the waterbody. Effective for small waterbody without recreational use (ex: golf, company)	Peer-reviewed (Lowney, 1993)	1) No 2) Urban context 3) No
Limits feeding	scaring migrating geese	brent	UK	Geese avoided taped fields compared to control fields without tape	Peer-reviewed (Summers and Hillman, 1990)	1) Yes, in combination with foraging areas 2) Agricultural fields outside foraging areas, coordination necessary 3) Yes, research to improve and use more technologies to scare geese while reducing the workforce. Cost-analysis in multiple contexts
		barnacle	Scotland	Geese were scared by human presence, gas-gun and plastic tape. Geese used 50% less agricultural fields, and moved to refuge sites. Damage avoided roughly equal to cost of scaring	Peer-reviewed (Percival et al., 1997)	
		pink-footed	Norway	Geese were scared by human presence ("active scaring"). Between 2 and 5 scaring actions per day is efficient More efficient early in season	Peer-reviewed (Simonsen et al., 2015)	
		White-fronted	NL	Scaring via the multiple techniques mentioned in (Faunafonds, 2009) and hunting lead to 6% increase in foraging per day	Report (Radboud Universiteit, Sovon & NIOO; Faunafonds) (Jongejans et al., 2014)	
		pink-footed	Norway	Too intensive scaring (probably via human presence, "active scaring") can lead to a high population decrease	Peer-reviewed (Klaassen et al., 2006)	
		pink-footed	Norway	With no designated foraging areas, scaring lead to a decrease in geese density and potentially increase total monetary compensation because more farmers are affected	Peer-reviewed (Jensen et al., 2008)	
		barnacle	Denmark	Preliminary results. Less geese droppings when the scaring device is on (plays a distress call when recognizing the geese vocalization).	Peer-reviewed (Steen et al., 2015)	
		barnacle, brent	NL, Schiermon- nikoog	The scaring performed by farmers with flare, scare crows and flags was stopped and led to a doubling of geese population	Peer-reviewed (Bos and Stahl, 2003)	
		unknown	NL, Friesland	Use of border collies is adapted for fields with cows or near city (where scaring sound induces disturbance to cows/people) It is relatively costly and labor-intensive, so the recommendation is to use it in combination with other scaring devices.	Report (Oord Faunatechniek; Faunafonds) (Oord, 2011)	

		barnacle	Scotland	No difference between zone without scaring activities and zones with visual scaring only	Peer-reviewed (Cope et al., 2003)	
	scaring summer geese	greylag	NL, Marle	Geese avoided fields with combination of Anthraquinone and black and yellow ribbons, but the independent effect of both is unknown.	Report (CABwim Consultancy; Faunafonds) (van Liere et al., 2006)	
		Canada geese	USA	Laser 68-mW continuous-wave, 650-nm 96% of geese dispersed from laser-treated plots. They were repelled during the night but not during the day.	Peer-reviewed (Blackwell et al., 2002)	
		Canada geese	USA	Long-term crop avoidance was reached with the Goosebuster (on-demand alarm call sender) coupled with firing screamer and bangers shells. No habituation was observed during the 100-day study.	Peer-reviewed (Whitford, 2008)	
Limits feeding	Scaring devices sharing	unknown	NL, Noord-Holland	It can be efficient if 4 conditions are met: - less than 15 km between participants - scaring devices have to be costly and efficient - Every participant pays an equal amount - Scaring devices have to be accessible enough for all of them	Report (Wageningen UR; unknown) (Schoutsen, 2004)	
	coordinated scaring supported by hunting year-round	greylag, barnacle, white-fronted	NL, Hoekse Waard	A coordinated approach (scaring and hunting done whenever it is needed) compared to the normal approach (maximum 3 times per week hunt and 2 times per day scaring when damage is observed) resulted in : - less damage in winter wheat (5 vs 40 euro/ha) - less geese presence (4 vs 12 individuals/ha) - a higher number of geese scared (140 vs 45 individuals/ha) and hunted (3.6 vs 3.1 individuals/ha) - longer time spent scaring/hunting (2h50 vs 1h50/ha)	Report (Bureau Waardenburg; Faunafonds) (Lensink et al., 2014)	
	winter foraging areas	all	NL	% geese in winter foraging areas was stable for 8 years (average 60%), so no learning effect happened	Report (Sovon; Ministry/Faunafonds) (van der Jeugd et al., 2008; Schekkerman et al., 2013)	1) Yes, in combination with scaring 2) Large-scale, in combination with scaring 3) No
		white-fronted, greylag, bean	Poland	Geese prefer large fields far from forest and town, with high elevation for best vigilance. In the fall, preference for lower crops diversity, more maize stubbles (so less ploughed), less winter cereals, lower proportion of grasslands	Peer-reviewed (Rosin et al., 2012)	

		all	NL	Within designated winter foraging areas, geese prefer fields near roosts, far from roads.	Altenburg & Wymenga; Alterra) (Bos et al., 2008)	
Limits feeding	summer foraging area	greylag	NL, Tetjehorn	No significant difference in geese presence between fields in summer foraging areas of: White clover Alice, ryegrass BG3 and winter wheat. Probably due to the overall low geese presence and no scaring activities outside the summer foraging area.	Report (Sovon, Groningen) (Voslamber et al., 2015)	1) Yes, in combination with scaring 2) Important molting/breeding habitats 3) Yes, repeat pilot with scaring
	Culture modifications - taste	greylag	NL, Marle	Activated charcoal does not deter geese, but it can be due to the size of charcoal particles (Norit SA4 30 microns + adhesive FIR-MMC)	Peer-reviewed (Van Liere et al., 2009)	1) No 2) High-value crops 3) Yes, cost-Analysis
		snow	USA	Activated charcoal Ajad-Activaid (106 microns) decreased geese feces methyl anthranilate (Rejex-it AG-36) decreased geese feces	Peer-reviewed (Mason and Clark, 1995)	
		Canada	USA	Geese fed on corn seed with 1450 ppm Anthraquinone (Avipel) were 80% repelled	Peer-reviewed (Werner et al., 2009)	
		greylag	NL, Marle	Geese avoided fields with combination of Anthraquinone and black and yellow ribbons, but the independent effect of both is unknown.	Report (CABwim Consultancy; Faunafonds) (van Liere et al., 2006)	
	culture modification : type	snow	Canada	Geese prefer among legumes: 1) <i>trifolium pratense</i> 2) <i>medicago sativa</i> 3) <i>lotus corniculatus</i> Geese prefer among grass: 1) <i>Phalaris arundinacea</i> 2) <i>Dactylis glomerata</i> 3) <i>Bromus inermis</i> 4) <i>Phleum pratense</i> By adding less palatable plants like <i>lotus corniculatus</i> to the forage, geese will spread, and less damage will occur (because if too grazed, the plants die)	Peer-reviewed (Gauthier and Bédard, 1991)	1) Yes, but dependent on the landscape 2) Foraging areas, areas near roosts or breeding locations 3) Yes, study on effect of landscape on
		greylag	NL, Marle	Geese prefer White clover <i>trifolium repens</i> (brand Alice) over ryegrass <i>Lolium perenne</i> (ryegrass, brand BG3). Compared to fertilized grass, 1.6 X more geese droppings in the mixture clover-ryegrass, and 4 X more in pure clover than fertilized ryegrass	Peer-reviewed (Van Liere et al., 2009)	

		waterfowl (geese, swans, ducks)	World	Waterfowl select for high protein, soluble carbohydrate, water content, high digestibility, low fiber and low phenolic compounds	Peer-reviewed (Fox et al., 2016)	geese movement
Limits feeding	culture modification : type	greylag, barnacle	France	Preference for plants richer in proteins, but it decreases with geese size (lower metabolism)	Peer-reviewed (Durant et al., 2004)	
		Aleutian	USA	Prefer short sward grassland (particularly grazed by sheep, with shorter grass)	Peer-reviewed (Spragens et al., 2015)	
		unknown	UK	Reduced sward height and fertilizer application maximizes goose number within an area.	Peer-reviewed (Vickery and Gill, 1999)	
		greylag	NL, Tetjehorn	No difference in geese presence (feces) between fields of: White clover Alice, ryegrass BG3 and winter wheat. Probably due to the overall low geese presence and no scaring activities.	Report (Sovon, Groningen) (Voslamber et al., 2015)	
		unknown	NL	Within designated winter foraging areas, no difference of geese use between extensively and intensively-managed fields (in terms of fertilizer amount and harvest frequency).	Altenburg & Wymenga; Alterra) (Bos et al., 2008)	
		unknown	NL, Schiphol	In fields plowed maximum 24h after the harvest, bird presence before and after harvest did not differ. Given the belief that crop residues from unplowed harvested fields attract birds, this is an indication that the measure works to keep the number of birds low.	(Bos and van Belle, 2014)	

		all	Europe	<p>The smaller the wader, the more it requires protein-rich grass due to its high basal metabolic rate. Increasing agricultural intensification lead to colonization of smaller waders over time (from swans to ducks). The recent decrease in agricultural fertilization is predicted to first negatively affect duck population growth.</p> <p>A link was observed between geese population size and agricultural intensification, and not with hunting level.</p>	Peer-reviewed (Van Eerden et al., 2005)	
Limits breeding and feeding	General	greylag	NL	<p>From a population model, the population size at stabilization is more influenced by the adult survival than by egg or juvenile survival</p> <p>Big reductions in chick-rearing or breeding habitat leads to big reduction in population size</p> <p>Their model is underestimating the actual population growth probably because of the buffer-effect (geese use new kind of breeding habitats: city parks, near highways).</p>	(Baveco et al., 2013)	NA

Whether and how alternatives are implemented

The Dutch national law

The national government has a nature law (*flora- en faunawet*) in function since 2002. Geese are all protected under this law, except exotic species which are « animals, plants or micro-organisms that cannot reach the Netherlands on their own, but arrived through human activity » (Staatscourant, 2013). For example, the Egyptian goose is an exotic unprotected species, because it originates from human introductions in parks (Lensink, 1999), Table 2). Even though it is not protected, there are rules that limit the public to unnecessary harm these animals, as there are catching and killing methods restrictions, as well as a duty of care, for all animals.

Table 2 Goose species status in national Dutch nature law (Faunafonds, 2009).

Species	Latin name	status
Canada goose	<i>Branta canadensis</i>	Protected indigenous species
Greylag goose	<i>Anser anser</i>	
White-fronted goose	<i>Anser albifrons</i>	
Barnacle goose	<i>Branta leucopsis</i>	
Taiga Bean goose	<i>Anser fabalis</i>	
Tundra Bean goose	<i>Anser serristoris</i>	
Pink-footed goose	<i>Anser brachyrhynchus</i>	
Brent goose	<i>Branta bernicla</i>	
Egyptian goose	<i>Alopochen aegyptiacus</i>	Unprotected - exotic
Bar-headed goose	<i>Anser indicus</i>	
Domestic goose	<i>Anser anser domesticus</i>	Unprotected – domestic or naturalized

It mentions a list of prohibitions related to species that have the status of « protected indigenous species » (Table 2). It is prohibited to affect protected geese in these ways:

- Capture or kill the animal (article 9)
- disturb the animal (article 10)
- disturb the animal's nest (article 11-12)

These prohibitions apply except when there is damage (articles 65-68, see Table 3). Three different law tools can then be used when damage is observed: 1) the national and provincial exemption, 2) the provincial designation and 3) the provincial dispensation. Canada goose is on the national exemption list, meaning that prohibitions are cancelled despite being a « protected indigenous species » throughout the Netherlands. There is a provincial exemption to disturb geese with scaring (article 10) in all of the provinces. Finally, there is a provincial dispensation that has to be asked by the person who experiences damage or the FMU to the province. This is where most differences are observed between provinces because they all have a different approved Fauna Management Plan (hereafter referred to as FMP), with the exception of Drenthe that actually has no geese

management plan as of 2016 (Pers. Comm. P. Venema, 2016). **Importantly, the dispensation is more restrictive than the two others in that it has to be acquired via the FMU or province before every implementation.**

Table 3 Law tools for controlling geese damage (Faunafonds, 2009). Information on provincial exemptions were collected in provinces Regulation on flora en fauna law (*Verordening flora en fauna wet*) (See Appendix 1)

Article	Damage	Law tool	Species
65-66	Crops Cattle Forest Fisheries Water Fauna	National exemption (<i>vrijstelling</i>) for capturing, killing, disturbing the animal or its nest (articles 9-12)	Canada goose (the fox is also on this list)
		Provincial exemption (<i>vrijstelling</i>) - For disturbing the animal (article 10) , all provinces	Greylag, white-fronted, barnacle goose (Differences among provinces for the other species)
		- For scaring supported by hunt (article 9), provinces Friesland and Utrecht - Disturbing the animal's nest (article 11, 12) province Noord-Holland	Greylag, white-fronted and barnacle goose (outside foraging areas, in sensitive fields only) Greylag, barnacle, white-fronted and bean goose
67	Public health Public safety Air traffic safety Damage to crops, cattle, forest, fisheries, water, flora and fauna	Provincial designation (<i>aanwijzing</i>)	Unprotected species (Egyptian goose, domestic goose) for most of the provinces
68	forest, fisheries, water, flora and fauna	Provincial dispensation (<i>onthefing</i>) for capturing, killing, disturbing the animal or its nest (articles 9-12) and other articles related to the method or time of year : - Asked directly by the party to the province - Asked by the FMU through an approved management plan	Variable according to the province.

What are the law instruments for causing geese deaths

What we can extract from this law is that, when protected indigenous geese (except Canada geese) cause damage, they have the possibility to be killed generally only via the provincial dispensation, in which the conditions and implementations are written in a FMP that differs among provinces. Two provinces exempt: Friesland and Utrecht. Through their provincial exemption, greylag, barnacle and white-fronted geese can experience scaring supported by hunt in sensitive fields (example: potatoes, beets) that are outside foraging areas. There are variations in provincial dispensations between provinces, but mostly comprises damage control

in agricultural fields in summer and winter (where 2 preventive measures have to be implemented to get it), and population regulation through:

- Hunting in the summer (number of permits limited to the quota of dead geese desired)
- Hunting forming couples in February outside foraging areas (in all provinces except Drenthe, Overijssel and Friesland).
- Nest handling

In regard to gassing, some provinces have used it marginally, while in Noord-Holland around 30 000 geese were gassed in 2015 (Faunabeheereenheid Noord-Holland, 2015). There is a will for implementing a provincial dispensation in Friesland, Gelderland, Utrecht, Zeeland and Zuid-Holland and may turn into reality when the new nature law will enter into force (January 2017, Volkskrant, 2016).

Canada geese and unprotected geese species have no prohibition by the law for putting them to death. Due to other restrictions by law, like on the use of catching and killing methods and landownership access, the possibility of killing birds like this, is restricted though!

What are the law instruments for alternatives

The possibility to apply alternatives to killing geese is represented by:

- 1) The provincial exemption to disturb geese with scaring in all the Netherlands;
- 2) The implementation of 2 preventive measures (scaring in most cases, description available in (Faunafonds, 2009)). In most provinces, this is necessary to obtain the provincial dispensation for killing geese where agricultural damage is detected and to obtain the damage compensation;
- 3) For most provinces, a provincial dispensation exists for nest handling. Noord-Holland is the only one with a provincial exemption to do so.

Overview of alternatives in provincial nature policies

An overview of the *mention* of alternatives to killing in provincial nature policies is summarized in Table 4. Importantly, the fact that an alternative is mentioned or recommended does not mean that it is really implemented. Provincial nature policies have all been written after the 2012 failed geese-agreement, except for Flevoland and Limburg. Since before 2012, geese policy relied on the national foraging areas programs, it is logical to observe that the coverage of alternatives is low within these two provinces' policies.

What we depict from Table 4 is that alternative coverage is very poor, except for Noord-Holland and Friesland. Friesland nature policy declares about alternatives: "In many cases, these measures are difficult to implement, contrary to nature or agricultural interests, counterproductive, or very expensive, or move the problem. [...] Only in a customized way, such measures can contribute to a local solution". Noord-Holland vaguely says that it is desirable to look where alternatives could be implemented.

Among provinces, the most covered alternative is winter foraging areas, and it is consistent with the implementation in the field. Scientific sources are never used, and no clear law tools are described.

Table 4 Inventory of alternative measures to hunting and gassing mentioned in the 12 provinces nature/geese policies. Under the province name stands the year when the policy was implemented. See Appendix 2 for exact document references. Importantly, the fact that an alternative is mentioned in a policy does not mean that it is really implemented in the field.

Province	year	contraception	nest handling	fences	Predation	landscape/water level	culture modification	winter foraging areas	coordinated approach
Drenthe	2014		x					x	
Flevoland	2007							x	
Friesland	2014		x	x	x	x	x	x	x
Gelderland	2012		x	x				x	
Groningen	2014							x	
Limburg	2002								
Noord-Brabant	2016		x					x	
Noord-Holland	2014	x	x	x	x	x	x	x	
Overijssel	2014								
Utrecht	2014		x	x	x	x			x
Zeeland	2014							x	
Zuid-Holland	2014								

Overview of alternatives in provincial FMPs

An overview of the *recommendation* of alternatives in provincial FMPs is summarized in Table 5. Importantly, the fact that an alternative is recommended does not mean that it is really implemented. Since FMPs offer a more detailed description of alternatives than nature policies, the Table 5 distinguishes alternatives and the level of support in the FMP (recommended, only in specific areas, not recommended).

Generally, in FMPs one refers to the guide “Handreiking Faunaschade 2009” for more details on preventive measures, where the farmer is free to decide which preventive measure from the detailed list he will use. Apart from the usual acoustic and visual methods to scare geese, the guide also recommends to add alfalfa or trefoil to the mix of grass and clovers often used because geese have a weaker preference for this kind of crops (Gauthier and Bédard, 1991). In some FMPs, it is written that measures in this guide are mostly inefficient if they are not supported with hunting or when foraging areas are absent. They recommend interchanging the different kinds of apparatus and applying the methods randomly to increase the efficiency. Contrastingly, the FMPs of Friesland and Groningen even suggest to the province that scaring summer geese with alternatives should not be mandatory to subsequently allow hunting activities to reduce damage (Table 5). The reasons given for this advice are that they are unsatisfying and not effective.

What we can depict from Table 5 is that in the few cases where alternatives are well-covered (mostly Gelderland, Noord-Holland and Zuid-Holland), the general recommendation is to do a local-scale implementation. Generally, this conclusion comes from the thinking (partly supported by science, see Table 6 & Table 7) that a large-scale implementation would:

- Be too costly/ too labor-intensive;
- Cause side effects are likely to negatively influence other species;
- Displace the problem by inducing geese colonization elsewhere
- Not lead to a population reduction.

Only nest handling receives a consensus for implementation. In Friesland, it is believed that “playing with feeding or breeding availability is unrealistic” (De Vries, 2014).

Table 5 Inventory of alternative measures to hunting and gassing in the 12 provinces FMPs, and their level of recommendation: GREEN: recommended, ORANGE: recommended for specific cases only, RED: not recommended. Under the province name stands the applicable years of the FMP. See Appendix 3 for exact document references. Importantly, the fact that an alternative is mentioned in a policy does not mean that it is really implemented in the field. Note that province Drenthe is absent from the table because they have no geese FMP as of 2016.

Province	Year	contraception	nest handling	Fences	predation	landscape/water level	culture modification	winter foraging areas*	coordinated approach	scaring without hunting	summer areas without disturbance*
Flevoland	2014-2018		x				x				
Friesland	2014-2019									x	
Gelderland	2014-2019		x	x	x	x	x	x			
Groningen	2014-2019		x	x						x	
Limburg	2015-2020		x								
Noord-Brabant	2011-2016		x						x		
Noord-Holland	2015-2020	x	x	x	x	x	x	x			
Overijssel	2014-2019		x								
Utrecht	2014-2019		x	x	x	x	x				
Zeeland	2015-2019		x	x			x				
Zuid-Holland	2015-2020	x	x	x	x	x	x	x	x		x

* The recommendation is for implementing new foraging areas (so that a province can have an empty space even if there are already foraging areas there (summer and winter).

How FMPs use science

An overview of science used in FMP and used to support FMP claims related to alternative measures is presented in Table 6 (the overall scientific literature review can be found in Table 1). Since there is a poor coverage of alternatives present in both policies and FMPs, the coverage of scientific literature is also poor.

Again, most of the scientific literature is present in the same three provinces who analyzed it well: Gelderland, Noord-Holland and Zuid-Holland (60% of all references to science, see Table 6).

While the scientific literature review from Table 1 shows that alternatives can have an effect on geese population size through reducing breeding/feeding opportunities, FMPs use of science is mostly to justify why they think measures should be implemented at a local scale only. Table 7 contains a list explaining how the scientific studies are used by FMPs, and presents what the unbiased facts really are from the perspective of a scientist looking at animal welfare. From this table, we can see that FMPs use of science is somewhat biased towards mentioning the negative sides of alternatives, which are often not shown in the studies themselves. This distorted view of science is not surprising because most of the effective alternatives offer a solution to geese damage on the long-term. The FMPs have the incentive of rapidly reducing geese populations by large numbers in order to reduce damage.

Table 6 Review of scientific sources used in FMPs from the 12 provinces for alternative measures. FMPs that contain the source are present in the last column. Abbreviations are D (Drenthe), Fl (Flevoland), Fr (Friesland), Ge (Gelderland), Gr (Groningen), L (Limburg), NB (Noord-Brabant), NH (Noord-Holland), O (Overijssel), U (Utrecht), Ze (Zeeland), and ZH (Zuid-Holland)

Effect	Alternative method	Claim about the way to use it or its efficiency	Source	Provinces
Limit reproduction	Nest handling	Too labor-intensive with limited effect. So it can only be implemented at a local scale	(Baveco et al., 2013; Kleijn et al., 2012)	Ge, NH, Ze
	Fences	Decrease geese reproductive success	(Brandsma, 2012; Voslamber, 2010)	Ze, ZH
		A possible part of the quantified decrease may be due to families escaping	(Voslamber, 2010)	Ze
	Predation	Decrease in breeding success not enough for causing a decrease in population size, effect on other species	(van Manen and Voslamber, 2013; Voslamber et al., 2012)	Ge, NH
		Negative effect on meadow birds	(Gijsbertsen and Teunissen, 2013; Teunissen et al., 2005)	ZH
	Fences and predation	Both can decrease attractiveness of breeding location	(van Manen and Voslamber, 2013)	Ge
		Alternatives based on decreasing the reproduction do not reduce damage done by molting individuals that come from elsewhere	(van der Jeugd et al., 2006)	D, Ge
Displace the problem to the neighbor when making breeding places unattractive		(Baveco et al., 2013)	ZH	
Limit feeding	Scaring	Type of preventive measures recommended	(Faunafonds, 2009; Oord, 2002; van der Weide and Rijks, 2013)	D, F, Ge, Gr, L, NB, NH, O, U, ZH
		Habituation, it has to be random and tools must be changed for increasing efficiency. A coordinated approach is better	(Faunafonds, 2009)	D, Ge, L, NB, NH, ZH
	Winter foraging areas	No learning effect by geese	(Schekkerman et al., 2013)	Ge, NH
	Summer foraging areas	Summer foraging areas with clovers did not attract geese	(Voslamber et al., 2013)	ZH
	Culture modification	Type of culture or substance to use	(Faunafonds, 2009)	Fl, Ge, Gr
		The effect of Anthraquinone is uncertain	(van Liere et al., 2006)	ZH
		Plowing crop residues is effective	(Bos and van Belle, 2014)	ZH
Clovers are four times more attractive than ryegrass		(Van Liere et al., 2009)	ZH	
	Summer foraging areas with clover did not attract geese	(Voslamber et al., 2013)	ZH	

Table 7 Comparison between FMPs use of science and interpretation by a scientist looking at animal welfare

What FMPs conclude based on science	What can be concluded looking at the same science in an animal-welfare point of view
Fences, nest handling and the fox cannot allow a population reduction to the desired level (of year 2005).	<ul style="list-style-type: none"> - Fences effect on population cannot be known from a short term study like (Voslamber, 2010). Following population dynamics, the population should reduce its growth in the long run. - When only nest handling is performed (not combined with other measures), it can lead to a stabilization and not a decrease (Baveco et al., 2013; Kleijn et al., 2012). - There was an indication that the fox reduced the number of geese where he had access (Voslamber et al., 2012). When looking at the whole nature area that comprises parts where the fox is absent, a population reduction was not observed.
The fox have a negative effect on meadow birds breeding success.	The study from (Gijsbertsen and Teunissen, 2013) does not evaluate a region where no fox is present, therefore its effect cannot be quantified. (Teunissen et al., 2005) show that the fox is an important predator of meadow birds' eggs, while it cannot be deduced that the fox is important for meadow bird <i>population decline</i> .
Measures for reducing breeding displaces the problem	(Baveco et al., 2013) deduced that new areas (cities, highways) can be colonized by geese because the population increased more than what their model had predicted. In the frame of the "buffer effect" theory (Gill et al., 2001), the new habitats colonized still remain less suitable for geese. In this sense, measures on breeding habitat suitability still reduce the number of available sites.
The reduction of reproduction success by fences is caused by families escaping.	The possibility of families escaping in (Voslamber, 2010) was because of the bad fence quality (non-metal material eaten by rabbits). When proper fences are used, this problem should be solved.
The goal of winter foraging areas was not reached because geese did not learn to go there.	A concentration of geese did not happen (Schekkerman et al., 2013), while from the study we cannot know if learning happened. Not enough coordinated scaring outside foraging areas can be one of the causes of lack of geese concentration.
Summer foraging areas with clover do not attract geese	There was no change in geese use of the area, so clover fields apparently did not attract geese (Voslamber et al., 2015). Researchers think that the attractive effect of clover was not observed because there was no scaring in the surroundings.
Anthraquinone effect is uncertain	It did not deter geese in the study (Van Liere et al., 2009). However it worked with Canada geese in the USA using different particle size (Ayers, 2009; Werner et al., 2009). The difference in size of the Anthraquinone pellets may be relevant in terms of its effectiveness to deter geese.

Overview of implemented alternatives

Since the content of policies and FMPs does not constitute an adequate picture of which alternatives have been really implemented in the field, an overview of known implemented alternatives is present in Table 8. The information is gathered from a variety of sources: policies, FMPs, interviews, scientific reports, etc.. It is possible that not all implementations are present since the information is not gathered in a standardized way.

Alternatives for summer and winter geese

An alternative that touch both winter and summer geese is the coordinated approach, where an implementation of optimal scaring is possible with paid workers. Optimal scaring is done through implementation at the right time, with the right frequency and with a combination of measures to avoid geese habituation. A coordinated approach is present in Flevoland (with paid hunters, (Lambooij, 2015)) and in Utrecht, with a “geese management team” (*Projectteam ganzenbeheer Utrecht*). In Utrecht, the goal is to support management activities when the actual measures are not sufficient to reach management goals and in more difficult areas (ex: near highways or in places highly used for recreation) (Smallegange and Nuisl, 2014). It seems that in agricultural areas, hunters were in no need of the support offered by the team and limited activity is done by the team here (Pers. Comm. R. Beenen & R. Zoer, 2016). Important to note that in both cases, no data is available yet to assess whether the coordinated approach allow gains in scaring efficiency, reductions in damage, and therefore reduces the necessity to kill geese. Such an evaluation should be available for province Utrecht in the near future (Pers. Comm. R. Beenen & R. Zoer, 2016).

Table 8 Inventory of alternative measures to hunting and gassing known to be implemented in the 12 provinces. The information is gathered from a variety of sources: policies, FMPs, interviews, scientific reports, etc. x= present

Province	nest handling	Fences*	predation	culture modification	winter foraging areas	coordinated approach	summer areas without disturbance
Drenthe	x				x		
Flevoland					x	paid hunters	Oostvaardersplassen, Lepelaarplassen, Harderbroek, Ijsselmonding, Ijsseloo, Ketelmeer
Friesland	x	de Deelen			x		
Gelderland	2015: 8 000 eggs				x		
Groningen		't Roegwold (Schildmeer)			x		
Limburg					x		Maasplassen
Noord-Brabant					x		
Noord-Holland	2012: 83 000 eggs			Elephant grass, Plow crop residues	x		
Overijssel	x	de Wieden					
Utrecht	2014: 10 500 eggs	APL-polders				Projectteam Ganzenbeheer Utrecht (PGU)	
Zeeland	2013: 1 000 nests	Axelse Kreek			x		
Zuid-Holland	2013: 4 400 nests	Kagerplassen, Veenweiden, Oeverlanden, Hollands Diep, Oosterse Bekade Gorzen, Tongplaat					

*Provinces where fences have been implemented inventoried in (Guldemond et al., 2012).

Alternatives for winter geese

The exact “winter period” differs between the Northern provinces where it is from November 1 – March 1 whilst in Southern provinces it is from November 1 – February 15. The exception to that is Friesland, where it only lasts two months in the first two years of the FMP (2014-2015). From (Pers. Comm. K. Talma, 2016), policymaker Friesland, this length is not extended as long as an analysis of the first two years has not been properly done.

Most of the provinces stick to the plan of keeping “peace” during winter (Table 8), with no disturbance of geese in foraging areas (while outside, scaring can be done). Multiple provinces reiterate that these areas must be present for meaningful/successful scaring activities. In general, when geese damage is detected, a **provincial dispensation** can be obtained via the FMU (and in particular cases directly to the province) to hunt greylag, white-fronted and barnacle geese under three conditions:

- Outside delimited foraging areas (which Zuid-Holland, Utrecht and Overijssel do not seem to have);
- For “sensitive crops” only, which generally excludes year-round grasslands (example: potatoes, beets);
- If a minimum of two preventive measures (mostly scaring) have been implemented.

Applying two preventive measures is also a condition for receiving a monetary compensation for geese damage by *Faunafonds*.

Alternatives for summer geese

Contrary to winter (Table 8), most provinces do not have summer-foraging areas where geese are not disturbed. This is because the logic of the winter-foraging areas was to create a safe haven for migrating and wintering geese in the Netherlands. This is a legal obligation under European law (Vogelrichtlijn, Directie Natuur, 2004). The Netherlands is one of the most important stop-over and wintering grounds for migrating geese in Europe. As a secondary goal, creating these foraging areas would also allow farmers not situated in these areas to scare geese away by hunting to reduce damage. The concept of summer foraging areas has similar goals: concentrate geese damage by resident geese in the summer and allow them a place where they can breed/feed in peace. Summer foraging areas in agricultural zones exist only in Maasplassengebied in Limburg (also called tolerance areas, *gedooggebieden*). It works the same way as with winter foraging areas: farmers that participate do not disturb geese and are compensated for the damage. This implementation was motivated by the fact that it harbors a distinct population of greylag geese (Geuns and Tije, 2006), where geese from Germany and Belgium come to molt (Faunabeheereenheid Limburg, 2015). Only Flevoland determined six of their nature reserves as core areas (*kernen*, which comprises Oostvaardersplassen, see Table 8), where no disturbance is made to geese there and they have opportunities for feeding on grassland areas also grazed by large herbivores.

In general, when geese damage on agricultural fields is detected in summer, the same mechanism as in winter (provincial dispensation for scaring supported by hunting) applies, except that there is no foraging area (except the two cases mentioned above), and that there is no distinction between the kind of crops. Friesland and Utrecht distinguish themselves in that they have the provincial exemption for scaring supported by hunting (Table 3). It means that no permit from the FMU or the province is needed. Nest handling is done by most of the provinces, but the extent of their actions is difficult to know (seldom reported, also in different units: nests or eggs). Culture modification is known to have been implemented around the sensitive Schiphol Airport, Noord-Holland through:

- Elephant grass cultivation (*Pennisetum purpureum*)
- Plowing maximum 48 h after harvesting corn to avoid geese to go feed in crop residues (Bos and van Belle, 2014).

From (Pers. Comm. R. Beenen & R. Zoer, 2016), there was also a willingness to implement Mangalica (or Mangalitza) pigs in Utrecht, because of the knowledge that pigs like to eat geese eggs. However, given the absence of a suitable area, it was not implemented.

Summary of stakeholders' input: researchers, policymakers, FMUs and provincial deputies

Interviews

Telephonic and direct interviews have been performed with researchers, policymakers and FMUs in May to July 2016. The details of how they perceive the scientific support and implementation of alternatives are presented in Table 9Table 10.

Briefly, researchers generally think that there should be more research, in particular we would need to know more about demographic parameters (like survival, death and reproduction success) of geese populations. They also think that diverting management responsibilities to the 12 provinces was a bad idea. They suggest a nationwide management plan, and preferably an international management plan, because geese do not have borders. Fences and modifying the landscape are viewed positively by them.

Policymakers and FMUs first impression is that we don't need more research, but almost all of them would like to know how the measures implemented in other provinces affect the number of geese within their own province. They mostly think that the most important improvement in geese management is to reach the goal of reducing the resident population to the 2005-level. Policymakers see the fox as a possible alternative, but the willingness to implement alternatives in general is low because they focus on the still-not-reached goal: reducing the population. Often they say that they would see alternatives being implemented after the 2005-goal is reached. FMUs are quite reluctant towards measures that reduce the availability of breeding sites (fences, predation, landscape modification) because of conflicts with other nature goals (meadow-birds, specific species in nature reserves like the Eurasian bittern). Both policymakers and FMUs view that we would gain by having a more coordinated approach.

Survey amongst provincial deputies

The results from a survey amongst 42 provincial deputies that have nature-related tasks are described in detail in Appendix 4. This survey illustrates that deputies generally have good knowledge on geese management from various sources including objective, scientific sources. The geese problem is an important part of their total policy related work load and they find they cause too much damage, especially in agriculture. They consequently see farmers as the most important stakeholder followed by nature and animal organizations, hunters and citizens. They generally would like the influence of farmers, nature associations and hunters to be somewhat lower, while they would like the influence of citizens to be higher. They show a positive attitude towards various measures that have the potential to increase animal welfare and think that an investment is necessary and will potentially generate savings.

The potential for developing alternative measures is high because deputies have a positive attitude towards it, and they think that savings are possible. *Dierenbescherming* could try to increase deputies' knowledge on two animal-friendly methods that if implemented, can reduce damage of geese on long-term: the fox and fences around breeding locations. While there is good support for giving more space to the fox, this is not the case for

fences. With a more thorough knowledge on the fence-method, it could lead to more support and an increase in its use in future.

Table 9 Summary of interviews to researchers, provincial policymakers and FMUs, on alternatives for geese management. In green, the interviewee is positive about the measure, orange, more or less positive, and red, negative. In parenthesis, it is indicated the reason of why the interviewee was positive or not about the alternative. Empty cells are uninvestigated cases.

	Name, company	more science needed?	nest handling	fences	predation	landscape/water level	culture modification
researchers	Berend Voslamber Sovon	Yes		x		x	
	Adriaan Guldemond & Dirk Keuper CLM		x (displaces the problem)	x	x (opportunistic, displaces the problem)	x (displaces the problem, change the ecosystem)	
	Maarten Loonen Univ. Groningen				x		x (Elephant grass)
	Bart Nolet NIOO	Yes				x (land use changes)	
	Ralph Buij Alterra	yes	x (no effect on population size)	x		x	
	Aad van Paassen Landschapbeheer NL	yes			x (local)	x	x (overall agriculture)
	Sip van Wieren Univ. Wageningen	no	x		X		
policymakers	Ron Beenen & Roland Zoer Provincie Utrecht	yes (alternatives in general)	x (only intensive)		x (after manageable population)	x (after manageable population)	x (not relevant, mostly grasslands for milk production)
	Martien Mols Provincie Noord-Brabant			x	X	x	
	Rene Steijn Provincie Zeeland	Yes (impact of geese on farm profitability)			X	x	
	Peter Venema Provincie Drenthe	Yes (effect measures of neighbor provinces)			X		
	Klaas Talma Provincie Friesland	yes (effect measures of neighbor provinces)		x (after manageable population)	X		x
	Tirza Molegraaf & Willem Lambooij Provincie Zuid-Holland	yes (bird movement between provinces)		x			
FMU	Jeroen Nuijsl & Alfred Melissen FMU Utrecht & Limburg	Yes (effect measures of neighbor provinces, on geese behavior)		x (nature goals)	x (nature goals)	x (nature goals)	

Table 10 Summary of interviews with researchers, provincial policymakers and FMUs, over alternatives for geese management. In green, the interviewee is positive about the measure, orange, more or less positive, and red, negative. In parenthesis, it is indicated the reason of why the interviewee was positive or not about the alternative. Empty cells are uninvestigated cases.

	Name, company	winter foraging areas	coordinated approach	scaring	summer areas without disturbance	national/international coordination
Researchers	Berend Voslamber Sovon	x	x			x
	Adriaan Guldemond & Dirk Keuper CLM	x (they don't learn)	x (too costly)	x (displaces the problem)	x (high damage)	x
	Maarten Loonen Univ. Groningen	x				
	Bart Nolet NIOO	x (too much effort)		x (geese need more energy)		x
	Ralph Buij Alterra					x
	Aad van Paassen Landschapbeheer NL	x		x		x
	Sip van Wieren Univ. Wageningen					x
policymakers	Ron Beenen & Roland Zoer Provincie Utrecht	x	x	x (after manageable population)		
	Martien Mols Provincie Noord-Brabant	x	x (costly)	x	x	
	Rene Steijn Provincie Zeeland	x	x			
	Peter Venema Provincie Drenthe	x	x			
	Klaas Talma Provincie Friesland	x	x			x
	Tirza Molegraaf & Willem Lambooi Provincie Zuid-Holland			x (displaces the problem)		
FMU	Jeroen Nuissl & Alfred Melissen FMU Utrecht & Limburg		x	x (displaces the problem)	x (Limburg)	x

Summary of reasons given for a (limited) local-scale implementation of alternatives

From the different stakeholders studied (in provincial policies, FMPs and interviews), four important arguments came up to justify the limited implementation of animal-friendly alternatives (Table 11). They consist of: problem displacement, absence of population reduction, cost, and emergence of other problems, such as disturbance of non-target species. The scientific basis of these arguments has been thoroughly examined in Table 7, and does not (fully) support the four arguments.

Table 11 Four reasons given by stakeholders for supporting a local-scale or no implementation of alternatives. In the last column is added why these arguments are not valid to limit implementation of alternatives to a local-scale only.

Reason given	Provincial policies	FMPs	Researchers	Policy makers	FMIUs	Why the argument is not valid to limit implementation of alternatives to a local-scale only
The problem goes to the neighbor	x	x	x	x	x	A large-scale, national coordination should prevent a problem displacement
The goal of 2005 cannot be achieved		x		x	x	Some alternatives cause a reduction in chick survival, so they are a part of the solution (nest handling, fences, fox). Since the results of alternatives are generally expected to occur on long-term, they need to be implemented rapidly.
It is too labor-intensive/costly	x	x	x		x	Two studies show that a paid scaring team does not incur more management costs (see Table 12). Dutch politicians are willing to invest in alternatives (see Appendix 4).
It can cause more problems, such as disturbance of non-target species.	x	x	x		x	There is no scientific evidence of this. The disturbance caused by fences and nest handling on other species than geese must be compared with disturbance from hunting, which can be high (Grignolio et al., 2011). A thorough research should be performed on the effect of the fox on meadow bird populations.

6. Conclusion

Summary of findings and recommendations

In this section, it is discussed how the measure is described in policies/FMPs compared to the scientific evidence and general recommendations are given per measure.

Contraception

Contraception has few or no mention in FMPs. When it is mentioned, the information is extracted from the 'Geese toolbox', which only refers to Nicarbazin (Bynum et al., 2007). The other option, Diacazon (Fagerstone et al., 2006), is not taken into account. There is a good description of the commercialization of Nicarbazin and how it was a commercial failure due to the hunter lobby and the legal status of the species in the United States (MacDonald and Wolf, 2013).

Contraception has to be performed continuously (every day, or every year). It requires professional handling and raises health issues (for human and animals). Therefore, it cannot be seen as a realistic solution to the complete geese management problem. It would be realistic in cities (parks), if there is a local/provincial will to invest in it.

Recommendations

Provinces with relatively high numbers of geese that breed in cities could implement a first pilot in the Netherlands with the help of experts from the USA (for Nicarbazin and Diacazon). If the results are promising a verification/modification on how medication provided to wildlife is regulated should be performed in order to allow national implementation.

Nest handling

Nest handling is very similar to contraceptives, except that performing nest handling does not require professional staff and it does not raise health issues. This measure is well implemented in policies and FMPs. There is a high variability in terms of implementation between provinces (from no eggs handled to 83 000 in 2012 for Noord-Holland), where the effort does not seem to be linked to the gravity of the problem. It is known to be professionally performed within Amsterdam city (Peter van Poelgeest, Duurzaam Fauna Advies).



Figure 9 Geese nest that has been treated with oil (Duurzaam Fauna Advies).

Science related to this measure is mostly used in FMPs to justify the low use/promotion of this measure: this measure does not allow a population decrease, just a population stabilization at most if at least 70% of all eggs are found. The method is being described as very labor-intensive. The literature review done (Table 1) confirms this idea, and even adds that from a study on a Swedish population you can conclude that you would require an even higher amount of geese eggs found (88%) to lead to stabilization. Based on an expert opinion (Brandsma,

2012), nest handling in nature reserves is thought to disturb other species like Purple heron, Eurasian spoonbill, Western marsh harrier and Eurasian Bittern. Nest handling is thought to be poorly-suited for large-scale management (Pers. Comm. A. Guldemond & D. Keupers, 2016; Pers. Comm. R. Buij, 2016), because of both the possible negative effect on other species within nature reserves and the poor-effectiveness.

Recommendations

Nest handling alone cannot lead to a population reduction, but can be part of the solution by combining this measure with others. To implement nest handling actions at a larger scale, provinces should support group of volunteers from animal and nature protection organizations for the implementation.

Disturbance of other species than geese is one of the four important reasons given by stakeholders interviewed not to implement animal-friendly alternatives (From the different stakeholders studied (in provincial policies, FMPs and interviews), four important arguments came up to justify the limited implementation of animal-friendly alternatives (Table 11). They consist of: problem displacement, absence of population reduction, cost, and emergence of other problems, such as disturbance of non-target species. The scientific basis of these arguments has been thoroughly examined in Table 7, and does not (fully) support the four arguments.

Table 11). However, it seems that the disturbance from alternative measures is not weighted properly against the disturbance done by hunting. Science shows that hunting can heavily disturb non-target species: For example (Grignolio et al., 2011) demonstrated it with roe deer during hare and wild boar hunting. Provinces should keep this in mind when weighing alternatives like nest handling against other measures to be undertaken against geese damage, such as hunting.

Fences

Fences around breeding locations to reduce access of chicks to agricultural fields are included in the provincial exemption to disturb geese (Table 3). Geese are indeed indirectly disturbed because families are unable to leave the breeding habitat to agricultural fields. It is judged as a relatively animal-friendly measure because, although it induces a lower chick survival, on the long run it should discourage geese to use the nature reserve as a breeding habitat. It also tackles the cause of geese population growth, namely the easy access of chicks to rich food from intensive agriculture grounds.

Some FMPs have mentioned that it is a measure which decreases reproductive success, but that escaping is possible and that this leads to lower effectiveness. While this claim is reported in the literature review (Table 1), it is also mentioned that it is possible to minimize the chance of escaping: ensure the fence is 50 cm high, made out of metal for avoiding rabbit biting, with mesh small enough to avoid young-chicks to escape (5 cm) and avoid sheep fence (Voslamber, 2010). While the issue of chick death caused by being stuck in the fence is



Figure 10 Difference in geese grazing inside and outside the nature reserves delimited by fences (Voslamber, 2010).

mentioned by Zuid-Holland FMP from attempts in Kagerplassen and Veenweiden, (Voslamber, 2010) quantified that only 0.5% of all chicks died for this reason. The scientific literature also shows that this measure has a considerable advantage: the geese use of surrounding agricultural fields during this period decreases (Brandsma, 2012) and so should the damage.

Importantly, (van der Jeugd et al., 2006) determined that the first factor that will stabilize the Dutch greylag geese population is the availability of rearing habitat. Fences in this sense can be a powerful tool. Indeed, compared to nest handling, the ratio of handling time per breeding couple can be way lower.

Recommendations

To implement fences, provinces should make:

- Agreements on the measure with land owners, which are mostly nature reserves. For this, it is important that they are confident that fences will not significantly disturb the other species that they want to protect. (Voslamber, 2010) reported no apparent effect on other species and that removing the fence when geese start to fly (mid to end of June) limits disturbance as much as possible. Disturbance caused by fences must be weighed against disturbance of other management measures like hunting, that can itself be high (Grignolio et al., 2011).
- An incentive of action: Two ways are possible:
 - o An investment from provinces for providing adapted, long-lasting metal fences and have a yearly budget or collaboration with nature reserves for the settlement and removal of fences via their rangers (fences should 50 cm high, 5 cm mesh size, installed from begin April to end of June (Pers. Comm. B. Voslamber, 2016)).
 - o Setting up a group of volunteers to do it, in the same logic as the way hunters are implementing measures in the field. It could be possible with volunteers of nature and/or animal-welfare organizations. This latter option is judged much more realistic in the context of Zuid-Holland by policymakers (Pers. Comm. T. Molegraaf & W. Lambooi, 2016).
- FBE should ensure that an evaluation of these implementations is done and shared with other provinces. In Zuid-Holland and Groningen, fences have been implemented (Table 8), but nothing is known about the effectiveness.

Predation

Fox predation can be seen as a sustainable option because it is a natural element that should be allowed to regulate geese populations (see [here](#)). The implementation would be to stop fox hunting in selected areas where geese are breeding. In the law, the fox is on the national exemption, like the Canada goose (Table 3). Therefore the provinces have to date no power to prevent fox hunting. Before the national exemption came in charge, provinces had the possibility to restrict fox hunting totally or in specific areas. The province of Utrecht allowed fox hunting in areas with important meadow bird populations, and restricted the hunting in the woodland areas of the Utrechtse Heuvelrug, historically a suitable habitat for foxes (see [here](#)). When the exemption for fox hunting came in charge, the possibility for a regional approach disappeared. The use of fox predation in the management of geese therefore depends on the commitment of land owners such as nature

reserves (Pers. Comm. R. Beenen & R. Zoer, 2016), because they have the right to prohibit fox hunting on their own property (Pers. Comm. R. Steijn, 2016).

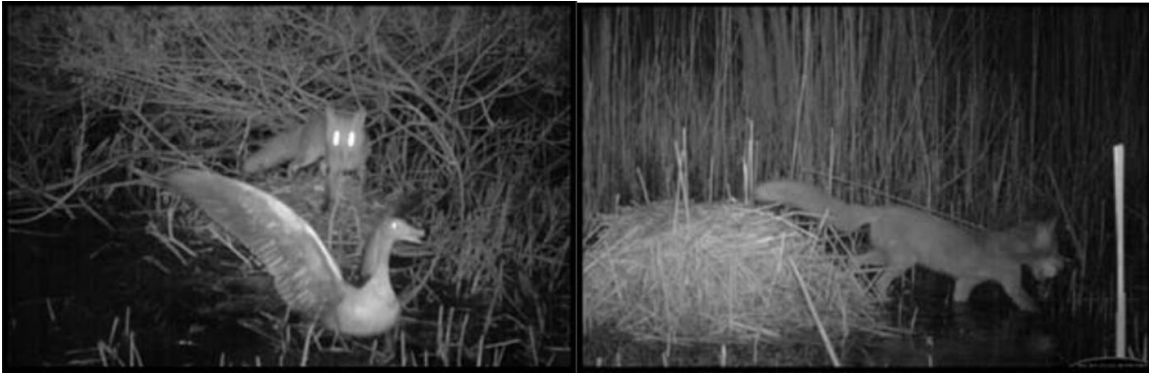


Figure 11 Events of nest predation by a fox in de Gelderse Poort

In FMPs, (Voslamber et al., 2012) is used to claim that the fox is not enough for a population decrease to happen, and (Gijsbertsen and Teunissen, 2013; Teunissen et al., 2005) to claim that it has a negative effect on meadow birds. (Voslamber et al., 2012) is the only report on the effect of the fox on geese reproduction, while from the researcher (Pers. Comm. M. Loonen, 2016), an effect of the fox on geese nests is observed in the *Rottige Meente* nature reserve, Friesland. In (Voslamber et al., 2012), predators of geese eggs in two areas of the *Gelderse Poort* were identified, and the movement of four foxes tracked. They showed that the fox was the most important geese eggs' predator (see Figure 11), and that his opportunistic behavior lead meadow birds to be an "alternative prey": During the geese breeding period, meadow birds have a low predation from fox, but higher after. A model for future development of the geese population revealed in the two areas studied either a declining or a stable population with the presence of foxes. They suggest that the increase of the geese population in the whole area of *Gelderse Poort* may be due to the absence of foxes in the other unstudied areas. From a more general perspective, predation in general is a high incentive of birds modifying their behavior in order to avoid it (Kahlert, 2003). Sea eagles in Estonia are indeed making geese leave the area (Pers. Comm. S. van Wieren, 2016).

In all, one can conclude that the claim of FMPs that the fox would not cause a decline in geese population is far from having support from the literature: (Voslamber et al., 2012) estimated that geese number in areas where foxes were present would be stable or decreasing in the future. This appears to be a promising measure because it is sustainable and can lead to a population decrease.

Recommendations

Before promoting this measure, it is important to:

- Invest in research where geese and meadow birds are surveyed in two separate regions, where one is clearly accessible to the fox and the other not, which is not the case in the only pilot studies we can rely on (Gijsbertsen and Teunissen, 2013; Voslamber et al., 2012). The policymaker from Zeeland thinks the fox has a high impact in maintaining the geese population relatively low (Pers. Comm. R. Steijn, 2016), but again a real quantification of this does not exist and would be a precious help for convincing other provinces it can work. More insight in the effect of foxes on both meadow birds and geese could lead to a change in the legal status of the fox. Only with a change of the legal status, we can stop fox hunting on a wider scale.
- Implement a case-by-case approach to evaluate where the fox presence should be promoted (avoid sensitive places with a high presence of meadow birds or free-range chicken farms (Pers. Comm. R. Beenen & R. Zoer, 2016). A similar “local-scale” approach is believed feasible in Noord-Brabant according to policymaker (Pers. Comm. M. Mols, 2016). In the context of damage caused by the “mouse plague” in Friesland, it would also appear a sensible solution to leave more space to the fox as to reduce the mouse population peaks (Pers. Comm. K. Talma, 2016). Keep in mind that the fox is opportunistic, that we therefore cannot guarantee that it will have the desired effect (eat geese eggs) in all areas. The effect will depend on other available food sources (Pers. Comm. A. Guldemond & D. Keupers, 2016). The effect on geese may therefore not be observed in all cases, but will have an effect if nationally implemented.

Modifying the landscape in nature reserves or city parks

These measures include less available islands in deep water, and remove grazers to let the ecosystem change from a prairie to a forest, the latter being unfavorable to geese (Table 1). (Pers. Comm. R. Beenen & R. Zoer, 2016) also indicated that changing plant composition in islands with for example brambles would be promising. In FMPs, it is mentioned that changing the water level is rarely feasible in the field and that it can negatively affect other species. Gelderland and Noord-Holland seem to be favorable for modifying the habitat so that it becomes less favorable for chick rearing/molting. FMP Gelderland mentions that they do not have reported any large-scale success for these kinds of measures within the province, but that the feasibility will be discussed in close consultation with land managers. The policy from Noord-Holland (2014) leaves the initiative to the land user and its FMP mention that it can be done at a local scale with limited result.



Figure 12 Horses and Egyptian geese in a Dutch nature reserve

From the literature review, it is known that letting nature reserves develop to their final succession state decrease overall habitat suitability for geese. (Pers. Comm. B. Voslamber, 2016) illustrates this with the *Ooijpolder* where natural succession of the nature reserve lead to a geese population decrease. Offering an easy

access to the rich agricultural fields to geese, small nature reserves dispersed in an agricultural landscape have a higher positive impact on geese populations, and so there the vegetation should be allowed to grow and reach its final succession state (van der Jeugd et al., 2006). While the same study suggest that succession is on-going in multiple nature reserves and so time will do much of the job, we can think that a global reflection on how we want nature reserves to become in the Netherlands is important for the geese problem.

The biggest problem of changing wetland-type nature reserves in such a way that it is not suitable geese habitat, is that it will lead to a more “forested nature”. Often this contradicts with the nature goals present for these wetlands, namely providing habitat for meadow birds. They need openness, not forests. Agriculture intensification is still the shared cause of meadow birds decline and geese increase. As long as society still decides that maintaining intensive agriculture is more important than avoiding meadow bird decline or geese increase/annual shooting, the pattern will continue. It’s all about choices: if we decide to keep intensive agriculture AND don’t want to shoot geese, then for a sustainable solution, we must fall back on modifying where geese breed: nature reserves, and less importantly city parks.

Recommendations

- Each FMU should elaborate a plan with the landowners (Staatsbosbeheer, Natuurmonumenten for example) or cities to target which nature reserves/city parks can be adapted for management modifications, similar to what has been done in Groningen (van Manen and Voslamber, 2013).
- When landscape modification is implemented, landowners/cities should monitor geese presence and present the results in a report for other provinces. Such a report seem inexistent to date except for (Boudewijn and Beuker, 2011).
- FMU should be an advisor when it comes to creating new nature reserves within the province.
- More efficiency will be reached if a thorough reflection on the nature policy throughout the Netherlands is done with nature managers (nature policy as it is now often promotes geese expansion (Pers. Comm. R. Steijn, 2016)). This is especially true for the implementation of dispersed nature reserves in an intensive agricultural landscape. This is highly subject to conflicts between human and wildlife in general, not only geese. Indeed, if all small nature reserves become unsuitable for geese by foresting, these reserves will be suitable for other species. These newly-favored species will in turn also be highly at risk to end dead if we continue having a low willingness/incentive to invest in animal-friendly measures.

Scaring combined to foraging areas

Science used by FMPs in this context usually consists of referring to the fauna damage guide (Faunafonds, 2009). This guide states that geese habituate to scaring devices and that therefore a random use of the scaring device and a coordinated approach is needed. They mostly use the experience in the field to claim a poor efficiency, while rarely quantifying it (exception to it: Flevoland FMP



Figure 13 White-fronted geese in a foraging area, Ackerdijsche Plassen, Zuid-Holland

p. 39). For foraging areas, they say that the program did not get to the desired effect of geese learning (Table 7).

In Flevoland, a coordinated approach with paid hunters can be afforded because the FMU holds hunting rights and receives money from their rent (which is not the case for all other FMUs). The hunting agreements are made under the condition that the FMU can perform hunting activities to reduce damage on these lands in case the local hunter cannot come to prevent this damage (Lambooij, 2015). There is a belief across researchers (Pers. Comm. A. van Paassen, 2016; Pers. Comm. B. Nolet, 2016) and policymakers (Pers. Comm. M. Mols, 2016; Pers. Comm. T. Molegraaf & W. Lambooij, 2016) that a national, coordinated, paid scaring unit would be too costly, in part because the case of Flevoland cannot be extended to the other provinces.

From science however, it is known that scaring can work cost-effectively, under the condition that there are enough geese-adapted foraging areas combined with enough scaring (2-5 actions a day during peak damage in spring). An experiment in Islay, Scotland, showed that an effective paid scaring allowed to spare roughly 0\$, as it cost the same amount than the sparing in terms of damage avoided (Percival et al., 1997). Coordination of scaring activities was also shown to reduce damage in a recent Dutch context (Lensink et al., 2014). See Table 12 for a comparison of both. Even in provinces other than Flevoland, a national coordinated scaring regime with paid people is therefore feasible. In the case of (Percival et al., 1997), it leads to a 0£ balance, with a creation of jobs. In the case of (Lensink et al., 2014), if you paid 12.50€/h for all the scaring time performed in the field for a coordinated approach (2h50/ha), it would lead to the same situation (0€ balance). It is therefore possible to pay people to do scaring without spending money (instead of compensating farmers for damage, provinces would pay scarers), and you have the advantage of effectively scaring geese to the foraging areas. It can even lead to substantial sparing when we consider that the amount government pay in compensation to mammals and birds damage is lower than the real damage (Guldmond et al., 2013), and so a paid scaring team could also avoid the not compensated damage. Of course, a large-scale implementation of coordinated scaring in combination with sufficient areas without disturbance is crucial in order to prevent the phenomenon of problem-displacement.

Table 12 Parameters for cost-benefit analysis of scaring in two different studies. Percival et al. 1997: Comparison between scaring without hunting and no scaring at all. Lensink et al., 2014: Comparison of a coordinated scaring versus a non-coordinated scaring (including hunting activities).

	(Percival et al., 1997)	(Lensink et al., 2014)	
Year	1987-1988	2012-2013	
Scaring period	16 weeks (spring)	Year-round	
Location	Islay, Scotland	Hoekse Waard, The Netherlands,	
Culture	Grassland	Winter wheat	
Measure	Coordinated scaring vs no scaring	Coordinated scaring vs no scaring	Coordinated vs non-coordinated scaring
Time scaring	1 h / ha	2h50 / ha	1h50 / ha
Number of geese reduced	0.52 geese / ha	15 geese / ha	8 geese / ha
Damage spared	5 £ / ha	115 € / ha	35 € / ha
Salary per hour	5 £ / h	0 € / h	0 € / h
Total sparing	0 £ / ha	115 € / ha	35 € / ha

From the communication with researchers (Pers. Comm. M. Loonen, 2016; Pers. Comm. R. Buij, 2016), it seems that the combination of scaring to foraging areas is promising and should continue in the future, but has to meet three conditions that would induce a geese learning effect, which were not met during the last foraging area program:

- Have long-term borders/agreements, low border/area ratio (so that the farmer cannot freely decide to change which land is foraging area or not from one year to another)
- Foraging areas situated in more adapted places (near roosts)
- Have sufficient coordinated scaring outside foraging areas (an unfulfilled condition according to policymakers (Pers. Comm. K. Talma, 2016; Pers. Comm. R. Steijn, 2016), which may have induced the feeling that scaring can only displace the problem to the neighbor (Pers. Comm. A. Guldmond & D. Keupers, 2016; Pers. Comm. T. Molegraaf & W. Lambooi, 2016)).

Recommendations

A National plan for improved foraging areas (improved location, shape, and scaring level) has to be made and is unlikely to be seen emerging from the divided provinces (Pers. Comm. P. Venema, 2016). Because the Netherlands takes part in a new international agreement for migratory geese including barnacle and greylag geese (AEWA, Pers. Comm. R. Buij, 2016), it can result in a national implementation and that it will be realized with funds following from that agreement.

In the meantime, provinces can still start to make changes to their own foraging areas by:

- Asking advice to experts as to where are the best locations to implement new foraging areas or to displace ones already implemented.
- Implement a coordinated approach with paid scarers, given that this approach induces no additional costs (Table 12).

Multiple benefits of this approach

Having paid people doing the coordinated scaring removes a lot of limitations present in the farmer work context (Schoutsen, 2004) would assure an adequate use of the scaring devices and would reduce farmers already high work load. We can think that if it is well implemented, it could even lead to sparing because:

- If geese learn, then the time spent scaring will logically also decrease (but will always have to be higher than 0);
- Efficient automated devices are in progress (A distress call is activated directly when geese are vocally-detected (Steen et al., 2015; Whitford, 2008), automated laser (Agrilaser), and a bird-of-prey robot (ClearFlightSolution)) and we can only predict more technological advances in the future. These have the potential to greatly reduce workforce costs;
- High efficiency could be reached with the use of a cell phone application where farmers can directly enter the geese position on their field which could communicate to drones which are then activated to go and scare geese.



Figure 14 Multiple technological tools for chasing geese. Up left and right: drones chased in Ottawa, Canada. Down left: Agrilaser. Down right: ClearFlightSolution.

Summer foraging areas

Summer foraging areas are present now only in Limburg (in agricultural areas) and in Flevoland (in nature reserves with large grazers). Consequently, scaring geese from fields where they are not welcome in the

summer, is only meaningful in these provinces. The Zuid-Holland FMP mentions it as feasible, and in Groningen there has been a pilot study by Sovon in Tetjehorn (Voslamber et al., 2013, 2015). There, near the lake Schildmeer, some fields were sown with clover, which are known to be preferred 4 times more than ryegrass by greylag geese (Van Liere et al., 2009). Results however show that geese do not concentrate on these fields, maybe because there were no scaring activities performed outside the clover fields. The reaction of the province was thus to abandon the idea because the cost of implementation was higher than the geese damage itself (Gedeputeerde Staten van Groningen, 2015).

This measure can be seen as risky because of the possibility to promote population growth, which can indeed happen if not enough scaring is done outside. However, if done in places with high damage of summer geese, the combination of coordinated scaring and foraging areas is meaningful, and could be integrated with the installation of a paid scaring team.



Figure 15 Greylag geese in Oostvaardersplassen, Flevoland.

Recommendations

A good step for provinces to improve the management of resident geese would be to follow the steps of Flevoland (Oostvaardersplassen) and Limburg (Maasplassengebied) and designate nature reserves that are important for geese and where no disturbance is present. In the present situation where the pressure for hunting geese is very high, it is particularly important to protect greylag geese according to their legal status. They deserve a place where they can live free of any human disturbance. A preference should be given to large areas, in order to have fewer borders with agriculture zones, which makes it harder for chicks to reach these zones. Overall, bigger nature reserves lower the risk of conflicts between agriculture interests and wildlife.

Culture modification

Applying substances like activated charcoal and Anthraquinone is mentioned in the fauna damage guide (Faunafonds, 2009) as a preventive measure. However, its use was not reported in one FMP where an inventory of the different preventive measures used in the field has been performed (FMP Friesland). Studies in the USA show a repellency effect of both substances. The only Dutch study performed shows no repellency of activated charcoal. However, this is likely due to the smaller-sized coal particles used in the Netherlands compared to the USA.

Recommendations

Provinces should promote the realization of a Dutch pilot on substances applied to cultures with products known to repel geese in the USA (Anjan-Activaid, Rejex-It AG-36 and Avipel) and in which the cost-effectiveness is quantified (cost of the product and damage avoided). At the same time, it is important to verify the necessity to obtain permission to use the product with the Dutch “*College voor de toelating van gewasbeschermingsmiddelen en biociden*” (CTGB). If necessary, this procedure should be started, to allow the product on the market.

The type of culture used has received quite a high amount of scientific research. Again, here FMPs mostly refer to the fauna damage guide (Faunafonds, 2009), with the exception of Zuid-Holland. Globally, the literature review shows that geese prefer high protein, carbohydrates and water content, low fiber and phenolic compounds content. These are all the characteristic that short grass grazed by large herbivores or cut by farmers have, more so if they are highly fertilized. The smaller the geese, the more they require these specificities because of their higher metabolism. But importantly, *preference* does not mean *choice*. They may exert a choice for less preferred food if the cost of travelling to the preferred field is too high for example. That is probably why the type of agriculture (intensive versus extensive) was a poorer predictor of geese presence than distance to roost during winter (Bos et al., 2008). At the other side of the spectrum however, it is expected that geese will effectively avoid long plants with a high amount of fibers, which all plants good for the biodiesel business have (Berendsen et al., 2014).

Recommendations in winter

- An effective action to improve foraging areas is first to select foraging areas near roosts, and let it consist of more attractive crops like clover (as location of the foraging area seems to be more important for geese use than the crop itself). It would be preferably implemented via a national plan, but can also be realized by provinces.

It has to be kept in mind that even if we would succeed in implementing very attractive foraging areas in the optimal places there may be a saturation effect: at some point, the population will reach a size where foraging outside will be better than inside because competition inside is high and food availability is reduced. In this perspective, scaring must be continued to keep discouraging that geese will go and feed outside these foraging areas.

Recommendations in summer

- Given the importance of available agricultural fields near breeding habitat for chick survival (and therefore population growth), putting repellent crops near breeding areas would decrease population growth. Here, we can think of incentives for farmers to engage in biodiesel production in designated areas. Examples of multiple repellent crops are given in (Berendsen et al., 2014) and include endophytics (tall fescue, Kentucky bluegrass), switchgrass, giant reed and hemp.
- Sensitive, highly-valuable crops should be avoided in areas of historical high geese usage (ex: potato and beet crops near roosts).
- (Van Eerden et al., 2005) shows that the increase in agriculture fertilization explain the change in waterfowl populations (swans, geese and ducks), and not hunting. Colonization of big grazers was first, and other species followed in decreasing size order. This represents well that an increase of fertilization allowed smaller and smaller species to be supported. Now there has been a fertilization reduction, which impacts first the smallest waterfowl, ducks. Following the logic, decreasing even more fertilization would continue the process until limiting one of the largest waterfowl and more problematic one, the greylag geese. Implementing an extensive agriculture all over the Netherlands would therefore not only reduce geese populations, but also increase meadow birds (which benefit from more extensive farming). There are big economical questions: Should we completely change the way we produce milk? Now the majority is industrial (encouraged by the quota loss in 2015) and exported into other countries. We could transfer to a less intensive milk production system. But are the economic losses of this less intensive milk production activity worth it, if you compare them to the economic (and environmental) gains of this change, such as less damage from geese? An economic study on the willingness of people working in the milk industry, and the Dutch population in general, to go into this direction is necessary. In this context, research on the real decrease in greylag geese following fertilization reduction (in line with meadow bird-friendly agriculture, (Pers. Comm. A. van Paassen, 2016)) is important, because there still exists the possibility that the level of fertilization that must be reached to effectively reduce the population can be lower than the one that was required to start population growth (Pers. Comm. B. Voslamber, 2016).



Figure 16 Elephant grass culture

Summary of recommendations according to interest groups

For provinces

The hunting solution is unsustainable because the target population size is the size at which population growth is at its peak. As a result, each year a lot of geese have to be killed. The current management gives little space for alternatives; however the survey amongst provincial deputies shows that Dutch politicians are willing to invest in alternatives. Some of these alternatives offer a sustainable solution (not having to intervene in the population each year):

- Agricultural change (less intensive → reduction in food availability for geese).
- Landscape modifications (vegetation succession/predation → reduction in breeding habitat availability).

However, these have a low chance to be changed in the near future (example: agricultural policies favoring milk production increase). That is why we urge **provinces** to work on promoting the implementation of three more animal-friendly measures that are less difficult to implement:

- A team of professionals paid for implementing a coordinated scaring, of which science shows that this gives no added management costs. If a pilot is started in one entire province, then the large-scale costs can be quantified, so that other provinces can follow. Pilots are really important for convincing provinces to act (Pers. Comm. K. Talma, 2016).
- Support existing networks of volunteers (such as those from animal welfare groups) that would assist paid professionals in adapting habitats and applying scaring devices.
- Increase the implementation of fences around breeding habitats, a measure that imitates a natural situation (in the past geese breeding success has been low, since food availability was lower). It is easy to implement and does not require a change in either agriculture or nature management. Provinces should invest in good-quality fences and in the yearly implementation.
- Provinces should make the effort of designating nature reserves for summer geese where no disturbance happens, preferably these are larger-size nature reserves.
- Support agricultural changes that reduce geese damage through sustainability funds.

A more proactive role from the province

It has been shown that provincial policies contain no science, whereas science from FMPs is biased towards the negative aspects of animal-friendly alternatives (Table 7). Globally, provinces seem to rely on FMUs to interpret science results, and therefore have more or less the same opinion about animal-friendly alternatives as FMUs: alternatives are more difficult, more expensive, do not solve the problem and create other problems (Table 11). In this report we have shown that science does not (fully) support these arguments (Table 7, Table 11). Most importantly, while *isolated* animal-friendly measures (like nest handling, fences and the fox) may not lead to a population reduction, the *combination* of them can result in a population reduction. Science also shows that coordinated scaring by paid people would not be more costly than the current management in combination with damage compensation.

We therefore advise provinces to be proactive and take the role of reuniting stakeholders in order to make real changes in geese management. For this, they must use science themselves, made more easily readable via the summary in Table 1. This is especially important since a large part of the science has been funded by the Dutch government, and should therefore serve the Dutch geese management, now to the responsibility of provinces. Also, a leading role of the province will result in a more animal-friendly management, something rarely achievable when the responsibility fall on private parties (the global, long-term view is missed this way).

For Bij12

Information exchange

Bij12 realized a registration system not only for the damage that is compensated, but also for the damage that is too small to be worth the handling fee for compensation. This will be a big step towards a good estimation of wildlife damage. They should also go in the direction to make a platform where important data on geese management from all provinces would be easily available. The data should cover:

- Population numbers and their distribution in summer and winter.
- Number of geese shot and gassed via the different dispensations and location.
- Number of eggs handled and location.
- Implemented fences and other sustainable non-lethal methods to reduce geese damage and their location.

Actually, the information is seldom reported/available in reports from FMUs or FMPs, and is not standardized (example: nest handling reported in number of eggs or in number of nests).

Improvements in research

Dutch scientific reports would gain in quality by having a bigger budget, which would also be more cost-effective. One carefully–implemented research where a conclusion can be drawn is worth multiple small reports where the low quality makes it hard to conclude anything. These are the research subjects worth investment and important for geese welfare:

- Research the effect of foxes on both meadow birds and geese.
- Research the long-term effect of fences on geese presence in nature reserves.

Three other subjects are very important for geese management and are missing in the literature:

- An update the research on geese damage in agriculture.
- An identification of the willingness of Dutch people to pay for geese, and to pay for an agriculture that accepts more wildlife damage, in a similar way to (MacMillan and Leader-Williams, 2008; MacMillan et al., 2004).
- A current quantification of the presence and number of bullets per living geese (especially the greylag geese) like (Noer et al., 2007).

For nature managers

A thorough rethinking of the management of the entire Dutch nature would be important, where all stakeholders should be part of (Natuurmonumenten, Staatbosbeheer, etc.). The most important gain in animal welfare for wildlife, including geese, is to reduce the amount of borders between nature and agriculture by discouraging a mosaic landscape and promoting bigger nature reserves. The less borders between nature and agriculture, the less human-wildlife conflicts.

For Dierenbescherming

When *Dierenbescherming* is viewed negatively by different stakeholders, it is because it experiences less the negative consequences of geese while perceived not to be an actor of change in the field. In this context, *Dierenbescherming* would greatly gain in support from the other stakeholders if:

- They would set up a volunteer team for animal-friendly alternatives in wildlife, for example nest handling in cities and setting fences in the field.

Promoting geese tourism so that Dutch people value more the life of a goose is also an excellent idea.

For farmers

- Farmers should register all geese damage on the website faunaregistratie.nl, which is independent of the process of receiving damage compensation. The precise quantification of damage is at present missing, even though this being crucial knowledge for geese management decisions.
- Farmers should consider seriously the application of Anthraquinone or activated charcoal to sensitive crops since research in the USA showed their efficiency (both Anjan-Activaid and Rejex-It AG-36 at 3.4kg/ha (Mason and Clark, 1995); Avipel, 1450 ppm (Werner et al., 2009)).
- Farmers could elaborate a plan following the location of historical damage made by geese. In zones with historical damage, the culture of biodiesel plants like elephant grass could be considered while the most sensitive crops would be sown far from these zones. Information for the practical implementation of elephant grass is available [here](#) (Snauwaert and Ghekiere, 2012).

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Appendix 1 – Provincial exemption references

Websites used to gather information on provincial exemptions (article 67, see Table 3) in the Dutch flora and fauna policies (usually named: *Verordening Flora- en faunawet* or *Verordening beheer en schadebestrijding dieren*).

province	year	Website
Drenthe	2005	link
Flevoland	2003	link
Friesland	2015	link
Gelderland	2006	link
Groningen	2014	link
Noord-Brabant	2007	link
Noord-Holland	2014	link
Overijssel	2014	link
Utrecht	2014	link
Zeeland	2003	link
Zuid-Holland	2013	link

Appendix 2 – Provincial policies references

Table 13 Reference of policies of the 12 different provinces, and their website link.

provinces	Year	Policy name	website link
Drenthe	2014	Flora- en faunabeleidsplan	
Flevoland	2007	Nota Flora & Fauna Flevoland - Over de kool en de geit	
Friesland	2014	De Fryske Guozzenoanpak	Link
Gelderland	2012	Kadernota faunabeleid	Link
Groningen	2014	Groninger ganzenakkoord	
Limburg	2002	Beleidsnota uitvoering Flora- en faunawet	Link
Noord-Brabant	2016	Hoofdlijnen nieuw ganzenbeleid Noord-Brabant	Link
Noord-Holland	2014	Uitvoeringsbeleid Ganzen Noord-Holland	Link
Overijssel	2014	Nota beleidsregels faunabeheer	Link
Utrecht	2014	Beleidsnota Flora- en faunawet	Link
Zeeland	2014	Zeeuws Ganzenakkord	Link
Zuid-Holland	2014	Uitwerking Ganzenbeleidskader	

Appendix 3 – FMPs references

Table 14 Reference of FMPs of the 12 different provinces, and their website link.

provinces	reference	website link
Drenthe	Oord, J.G., and Bruinzeel, L.W. (2009). Faunabeheerplan Drenthe 2009-2014.	
Flevoland	Borst, R. (2013). Faunabeheerplan Flevoland - Professioneel maatwerk voor mens en dier 2014-2018 (Arnhem).	Link
Friesland	De Vries, R.F. (2014). Faunabeheerplan Fryslân 2014-2019 (Wirdum).	Link
Gelderland	Salet, T., and Achterkamp, T. (2015). Faunabeheerplan ganzen - Grauwe gans, kolgans en brandgans in Gelderland 2014-2019.	Link
Groningen	van Manen, Y.J., and de Vries, R.F. (2014). Faunabeheerplan Groningen 2014-2019 (Wirdum).	Link
Limburg	Faunabeheereenheid Limburg (2015). Faunabeheerplan 2015-2020.	Link
Noord-Brabant	Faunabeheereenheid Noord-Brabant (2010). Faunabeheerplan 2011-2016.	Link
Noord-Holland	Faunabeheereenheid Noord-Holland (2015). Ganzenbeheerplan Noord-Holland 2015-2010.	Link
Overijssel	Faunabeheereenheid Overijssel (2014). Faunabeheerplan Overijssel 2014-2019.	Link
Utrecht	Smallegange, A.P., and Nuisl, J. (2014). Faunabeheerplan 2014-2019 (Veenendaal).	Link
Zeeland	Lensink, R. (2014). Faunabeheerplan Zeeland 2015 t/m 2019 : ganzen (Culemborg).	Link
Zuid-Holland	Visser, A., Keuper, D., Huber, M., and Guldmond, J. (2015). Faunabeheerplan ganzen Zuid-Holland 2015-2020 (Culemborg).	Link

Appendix 4 – Survey to provincial deputies

A survey has been performed to provincial deputies (*statenleden*) who had nature subjects as their task, from all provinces of the Netherlands. The goal was to know their level of knowledge on the geese issues and their opinion on which method and approach should be improved about geese management and related animal welfare issues in their province.

Table 15 Information on the survey's implementation and rate of participation

Number of provincial deputies who received the survey request	228*
Number of provincial deputies who completed the survey	42
% who completed the survey	18,4%
Period of possibility to complete the survey	July 4 to July 29, 2016
Survey tool	Google Forms

*Estimation. The exact number of deputies is known in 9 provinces (171). In the three other provinces (Friesland, Groningen and Zuid-Holland), the list of deputies with nature as their task was not directly available on provinces' websites. Estimation was made by allocating the mean number of deputies in the 9 provinces (19) to the three provinces with missing information.

Representativeness

While the rate of participation is low (18.4%), the number of participants (42) is big enough for avoiding statistical problems linked to small samples. General representativeness has been assessed using 3 questions: province, party and sex. Overall, there was a good representativeness considering the sample size. Only two provinces differ on more than 5% between the percentage of total Dutch population a province contains and the percentage of participants from the same province. In the survey, Zuid-Holland was underrepresented (-14%) whereas Limburg was overrepresented (+8%) (Figure 17). Related to the party, only two parties differed on more than 10% between the percentage of total provincial seats a party possess and the percentage of participants from the same party. In the survey, the party for freedom (VVD) was underrepresented (-12%) whereas the Party for the Animals (PvdD) was overrepresented (+22%). While there is a deviation from 50/50 in the survey's sex ratio with 57% men, this is less than the observed imbalance within provincial deputies who received the survey (66%). Possible biases therefore exist when extrapolation is made to the opinion of provincial deputies.

In terms of representativeness issues mentioned above, the overrepresentation of the Party for the Animals stood out the most, and therefore can cause the highest risk of bias. Care has been taken for this and data were analyzed with and without the deputies from this party. In almost all cases, the answer receiving the most support among deputies does not change. In the few cases where results *do* change, it will be mentioned.

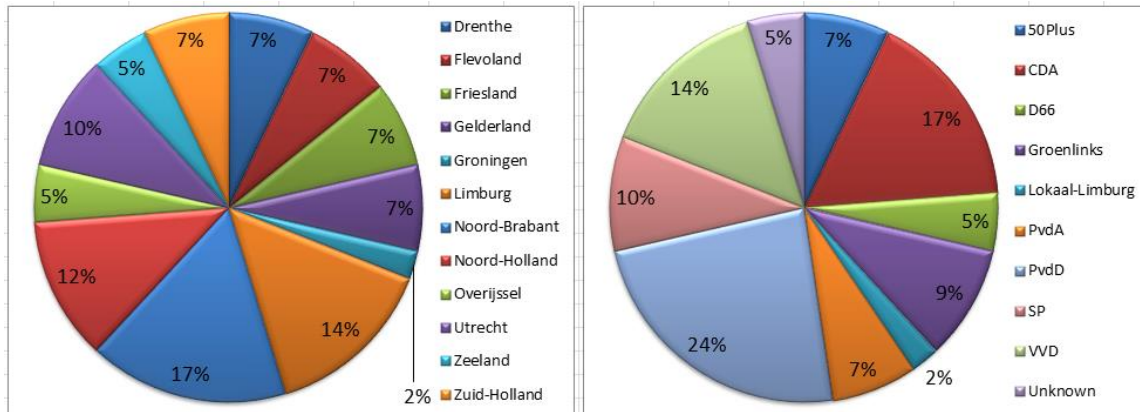


Figure 17 Division of provincial deputies within provinces (left) and parties (right).

Importance in deputies task and knowledge

The importance of the geese issue within the deputies' task is most considered of average importance (36%), while 43% rated it to be very- to most important subject. Within tasks related to fauna, most said it was very important (52%), while for 14% of them it was the most important fauna-subject.

Deputies obtain their knowledge on geese from a wide variety of sources (Figure 18). From the 11 sources available, more than 50% of the deputies mentioned that all sources (except citizens), were a medium to very important source of information. The majority of deputies mentioned Fauna management plan, law, reports from Dutch researchers and scientific articles as "very important", whereas the majority mentioned the rest as "somewhat important" (except citizen with "little important"). This supports the idea that deputies' knowledge is more based on research and governmental information than on interested parties.

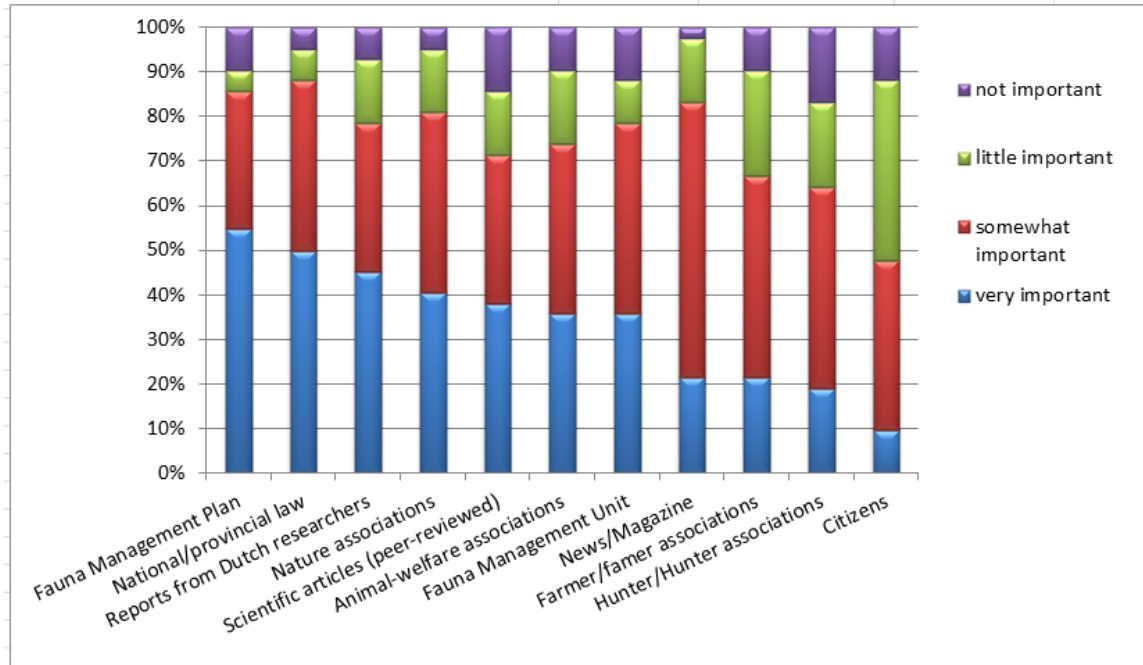


Figure 18 Origin of deputies knowledge about geese. For each source, the percentage of deputies allocating different level of importance to the source is shown. Sources are sorted in descending order of % deputies considering the source “very important”.

Level of damage

Forty-one percent of deputies think that geese are causing too much damage (Figure 19; excluding members of the party for the animals, the percentage increases to 53%) and 21% have the impression the damage is manageable. The most serious damage is inflicted to agriculture according to deputies. Deputies mostly rate this agricultural damage moderate to high (a total of 76% of the deputies). A majority of deputies think that airport security, nature, driving security and recreation suffer low to no damage in their province.

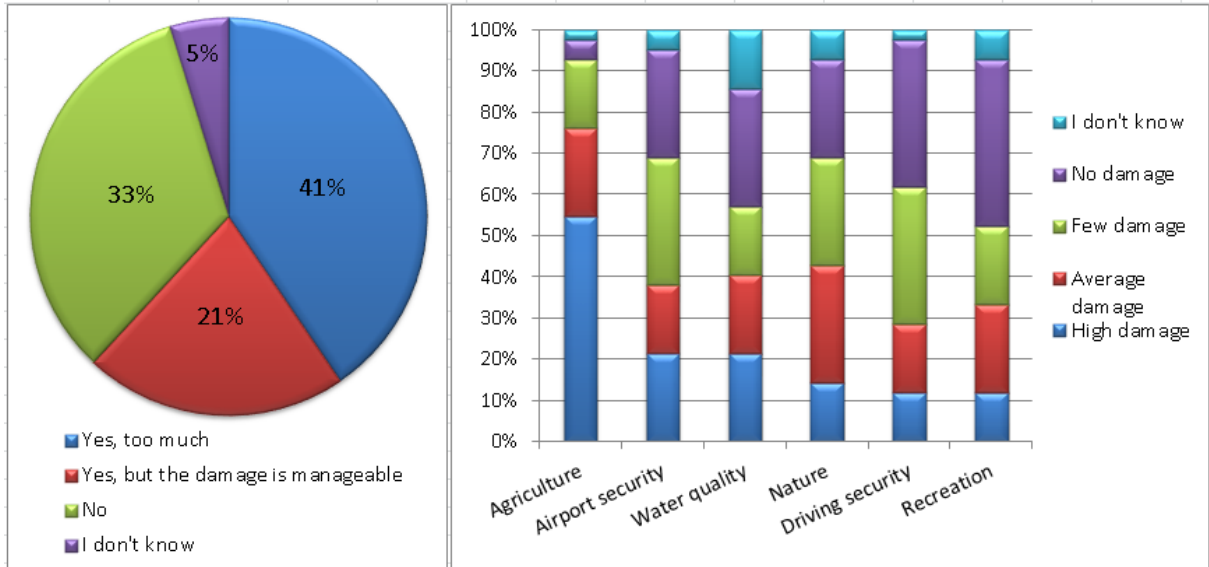


Figure 19 Level of deputies agreement to the question « are geese causing too much damage in your province » (left) and percentage of deputies allocating different levels of damage to different categories (right). Categories are sorted in descending order of % deputies considering that “high damage” is occurring in the category.

Influence of interest groups

The majority of deputies think that the level of influence of farmers is high, but they also think that they should have a high influence (76 and 55% respectively, Figure 20). Moreover, half of them think that animal protectors have an average level of both real and desired influence (45 and 52% respectively). The biggest difference seen between the real and desired influence is occurring with nature protectors, where their level of influence is seen in majority high (69%), whereas they mostly would like them to have an average level of influence (45%). Deputies mostly think that citizens should have a higher influence than their actual level (shift from low influence to average desired influence). Finally, with hunters, the majority think they have an average influence (42%), while the desired level is equally distributed between no influence at all and high influence (29% each). The pattern for hunters is highly influenced by the Party for the Animals, because when excluding them, a majority think they have a high influence (60%) and still a somewhat lower majority think they should have a high influence (37%).

Considering the level of animal-welfare in geese management, the general view of deputies diverges from the interest of *Dierenbescherming*. Indeed, half of them think that animal-welfare is considered enough in geese management (52%; Figure 21), while without the party for the Animals, it is nearly 2/3 of them (69%).

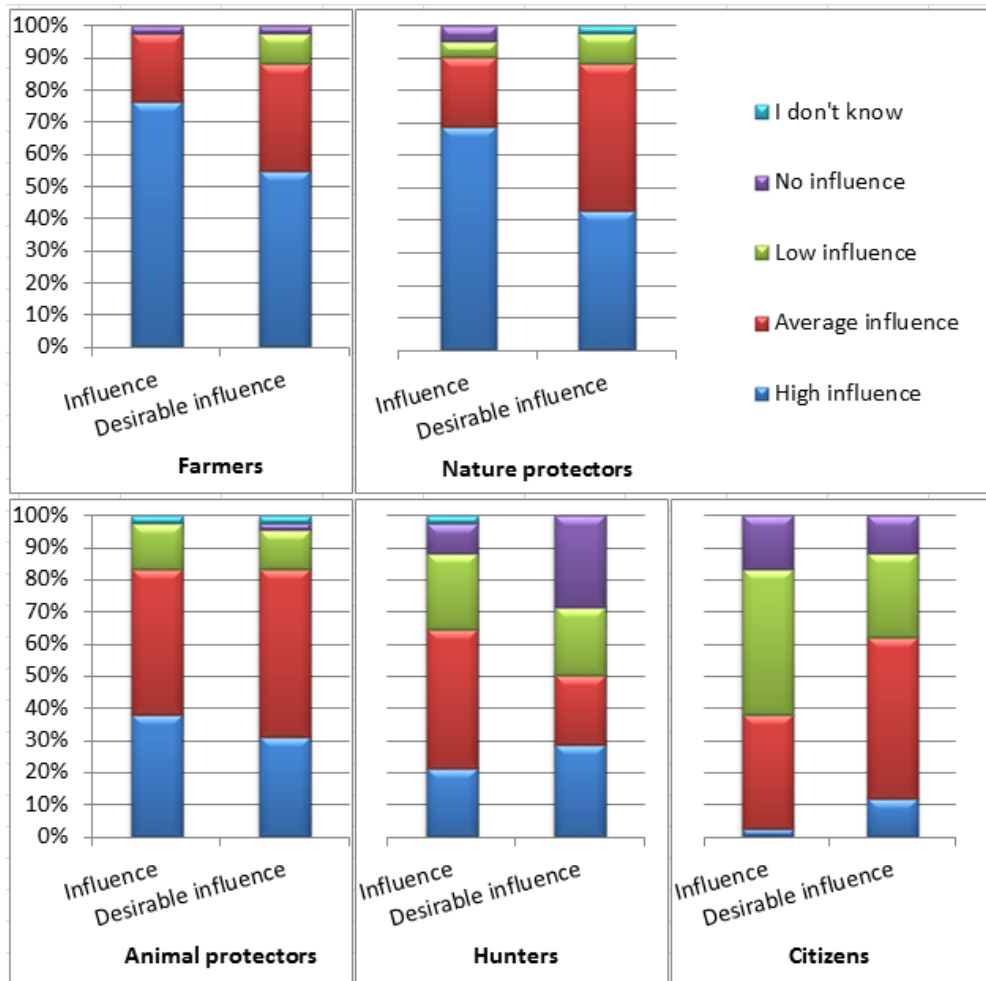


Figure 20 Level of influence deputies attribute to five different interest parties: Farmers (top left), nature protectors (top right), animal protectors (bottom left), hunters (bottom middle) and citizens (bottom right). Two columns per interest group are shown, representing the real influence deputies think they have (left column) and the desired influence deputies think they should have (right column). Level of influence is expressed as a percentage of deputies attributing different level of influence (no, low, average, or high influence).

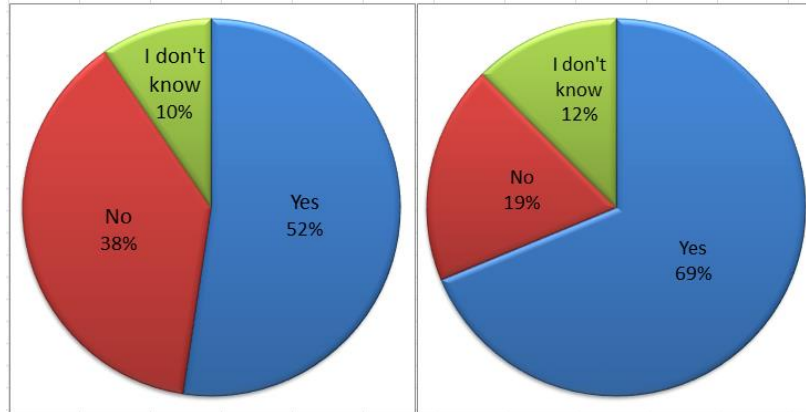


Figure 21 Answer to the question « Is animal welfare considered enough in the geese management? », with (left) and without (right) the contribution of the Party for the Animals, where their 10 deputies have all answered « no » to the question.

Improvement

The desirability of (14) measures to be implemented or improved was assessed, with a focus on measures that can increase animal welfare (Figure 22). Interestingly, the majority of deputies believe that an improvement or implementation of 12 of the 14 proposed measures would be desirable in their province, for which 10 of them have the potential improve animal welfare. The highest consensus (75%) is reached on implementing/improving monitoring and collaboration. Scaring with non-killing methods and fences around breeding locations are two animal-friendly methods for which deputies are quite divided on. A similar percentage thinks on the one hand that an implementation/improvement is desirable, and on the other hand, that it is not desirable because it is not sustainable/effective (45 vs 43% scaring, 38 vs 36% fences). The level of not knowing is quite low, reaching on average 13%. However, it reaches 17-21% for these measures: Collaboration, research in general, fox not hunted and fences around breeding locations.

The party for the Animals does not change what the majority of deputies think in this framework, except for two of the three causing the death of animals: Scaring supported by hunt and gassing (Figure 23). They are mostly believed to be not desirable because they are not sustainable or effective (both 45% support). However, this tendency is influenced by the party of the Animals, where excluding them leads to approximately half of the deputies wanting an implementation/improvement of these two (47% and 53% respectively). Finally, 48% of deputies want hunting for population management to be implemented/improved which increases to 62% when the party of the Animals is excluded.

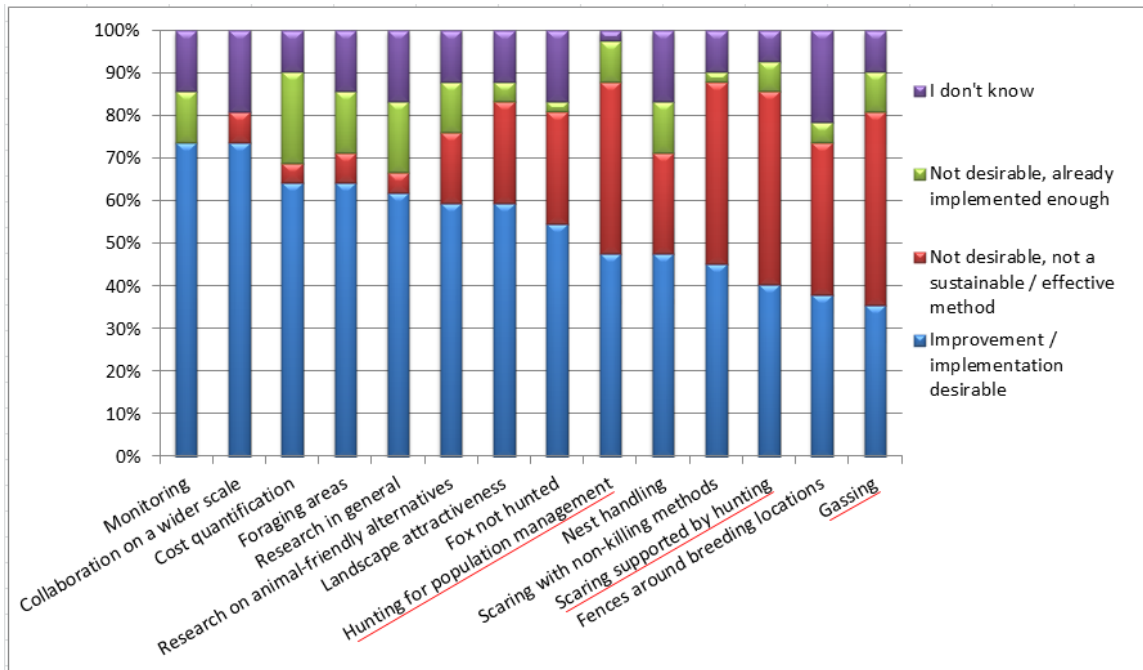


Figure 22 Deputies opinion about the level of implementation and improvement desired for various measures in geese management including measures that can result in an improvement of animal welfare. Opinion is expressed as a percentage of deputies attributing different level of implementation/improvement. Measures are sorted in descending order of % deputies considering the measure "Implementation/improvement desirable". The three measures leading to direct animal deaths due to human handling are underlined in red.

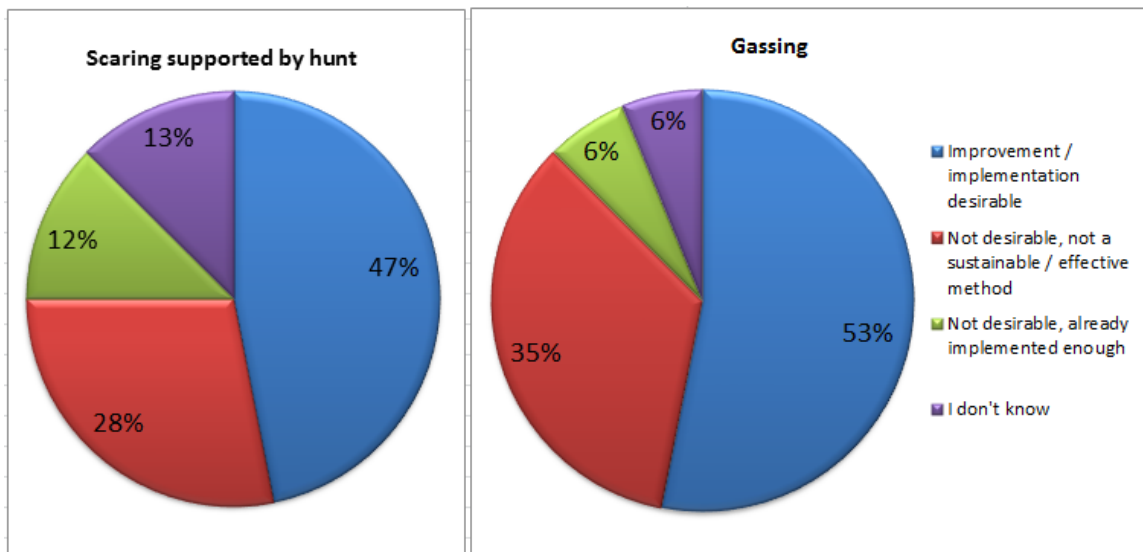


Figure 23 Influence of the Party for the Animals on the willingness of deputies to implement/improve two measures that are causing death of animals: Scaring supported by hunting (left) and gassing (right). Opinion is expressed as a percentage of deputies attributing different level of implementation/improvement.

Investment in animal-friendly methods

The majority of deputies think that an investment in animal friendly methods is needed (55%) and that it could lead to savings by decreasing damage (50%; Figure 24). To be noted that the last question obtained quite a high level of not knowing (17%).

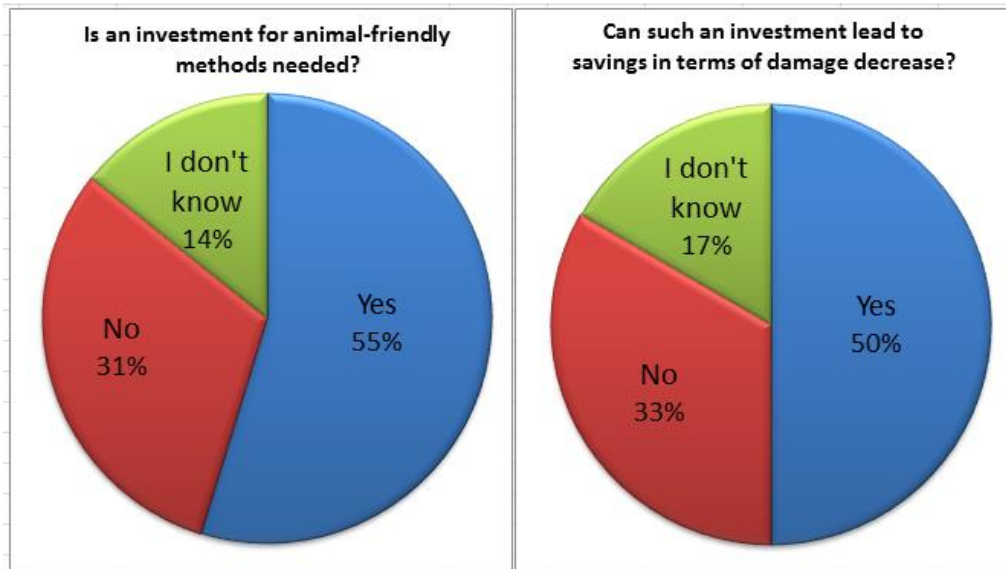


Figure 24 Deputies opinion about the necessity (left) and savings potential (right) of investing in animal-friendly measures.



IN 3 STAPPEN NAAR EEN DIERVRIENDELIJKER GANZENBEHEER

Aanbevelingen aan de provincies

1 **Neem de regie en maak een plan**

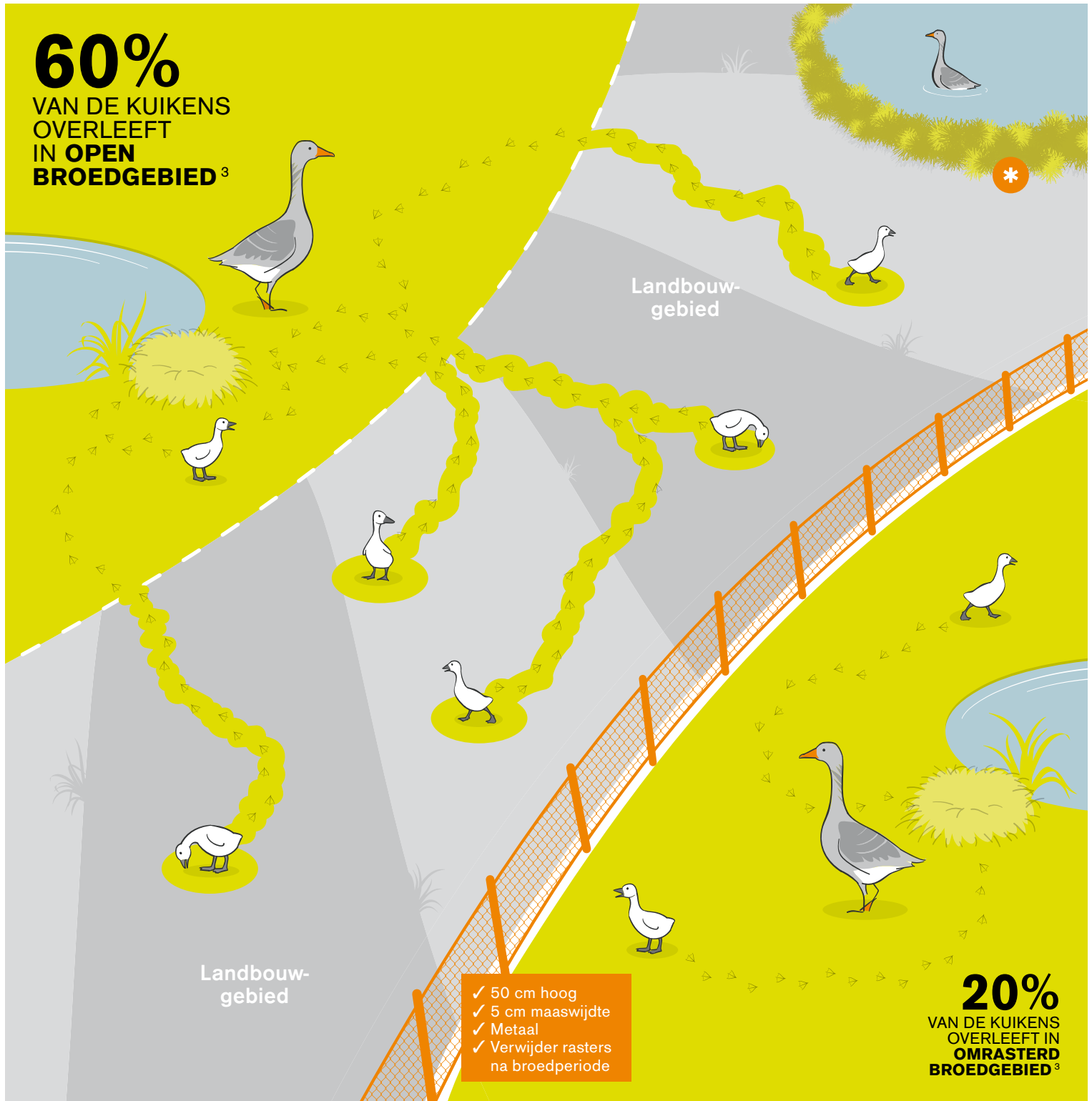
Een diervriendelijker ganzenbeheer is een complex vraagstuk. Niet in de laatste plaats omdat er diverse partijen en particulier grondbezitters bij betrokken zijn met allemaal een eigen belang. Beschikbare kennis over een meer diervriendelijke aanpak komt daardoor vaak niet tot zijn recht ¹. Toch

heeft de provincie juist baat bij een harmonieus model, waarbij minder schade wordt veroorzaakt (en vergoed) en tegelijkertijd minder dierenleed plaatsvindt.

De provincie is in de positie om hierin de regie te nemen door een plan op te stellen waarmee dit model in de praktijk gebracht kan worden. Daarin staan in elk geval de volgende twee stappen:

60%

VAN DE KUIKENS
OVERLEEFT
IN **OPEN**
BROEDGEBIED³

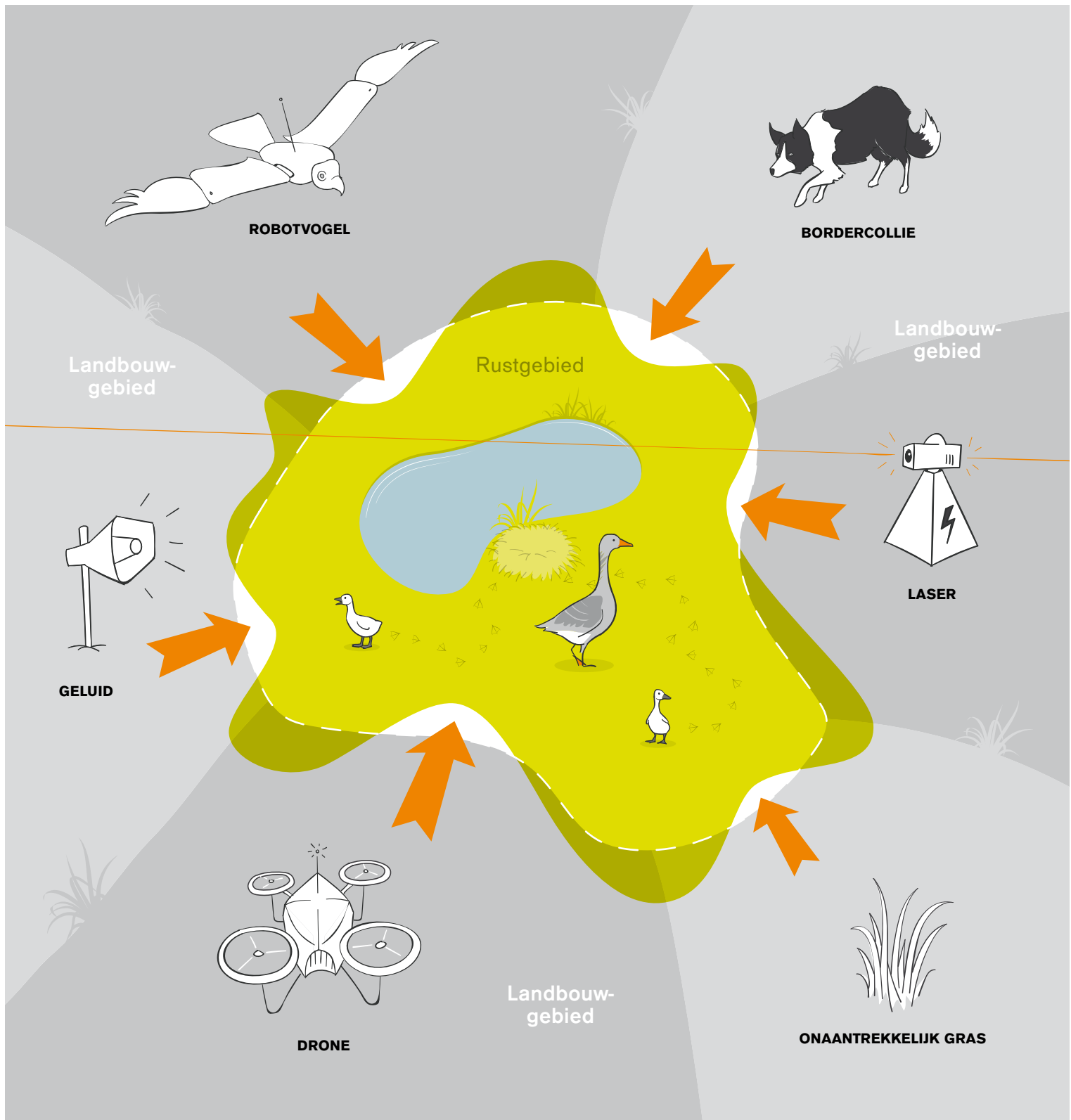


2 Plaats rasters rondom broedgebieden

Waarom zijn rasters effectief? Ganzenkuijken hebben nu makkelijk toegang tot rijke landbouwgebieden en overleven daarom eenvoudig, waardoor de populatie stijgt ². De rasters pakken die oorzaak aan: de overlevingskans van de ganzenkuijken neemt af. Vóór installatie overleeft 60%, na installatie nog maar 20% van de kuijken ³.

Zijn rasters diervriendelijker? Op termijn zeker! Omdat het broedsucces daalt hoeven minder ganzen te worden gedood door jacht of vergassing. Rasters zorgen er bovendien voor dat een gebied onaantrekkelijk wordt om te broeden.

* Datzelfde geldt voor dichte vegetatie zoals prikkelsruiken rondom waterpartijen. Daarmee worden waterpartijen minder aantrekkelijk gemaakt voor de ganzen.



3 Zorg voor een betaald verjagingsteam en voldoende rustgebied

Met lasers⁴, bordercollies⁵, angstgeluiden (per ganzensoort)^{6,7} en drones of robotvogels worden ganzen verjaagd uit gebieden waar ze niet gewenst zijn. Cruciaal is dat de ganzen wel het gehele jaar terecht kunnen in rustgebieden zonder verstoring^{8,9}.

En kies dan liever voor een groot rustgebied in plaats van meerdere kleine. Dat helpt om conflicten tussen mens en dier te beperken. Waarom is deze aanpak diervriendelijker? Ganzen zijn slimme dieren. Door meer verjaging leren zij waar ze wel en niet welkom zijn. In de rustgebieden kunnen de ganzen hun natuurlijk gedrag uiten, waardoor hun welzijn wordt gewaarborgd.

Door een betere verjaging neemt bovendien de noodzaak tot jagen af. Tenslotte toont wetenschappelijk onderzoek aan dat een betaald verjagingsteam niet meer kost dan de huidige aanpak^{10,11}.



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