

***Impact of increasing landscape  
openness on waders and avian  
predators in the Netherlands***



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## **Samenvatting**

*Tussen 1990 en 2011, toonden steltlopersoorten van alle vogel soortgroepen in Europa de grootste daling. Aangezien Nederland een relatief grote proportie van de steltloper wereldpopulatie bevat, heeft het een verantwoordelijkheid voor het voortbestaan van deze steltlopers. De afname van het open karakter van gebieden is aangewezen als één van de negatieve invloeden op het broedsucces van weidevogels. Toenemende vegetatie is gerelateerd aan een verhoogde predatie. Om predatie te verminderen worden riet, struiken en mogelijke nestbomen voor de Buizerd, Havik, Sperwer, Ooievaar, Blauwe reiger en Torenvalk verwijderd van weidevogel broedgebied. Deze review richt zich op de volgende vraag: Wat zijn de noodzaak en de effecten van het verwijderen van opgaande vegetatie (riet en houtachtige planten) van Nederlandse weidevogelgebieden op steltlopers en roofvogels?*

*Het vergroten van de openheid van weidevogelgebieden zal mogelijk een positief effect hebben op weidevogelpopulaties. Aangezien steltloperpopulaties nog steeds in aantallen afnemen zullen de negatieve effecten op hun reproductieve succes moeten worden verlicht. Echter, veel ander mogelijk belangrijkere factoren dragen bij aan de negatieve trends van de steltlopers. Hieronder vallen het waterpeil, maaidatum en kruidenrijkheid van het land. Doordat opgaande landschapselementen zoals de 'groenblauwe dooradering' verscheidene ecologische functies hebben en veel soorten daarvan afhankelijk zijn raad ik aan om eerst andere habitateisen te optimaliseren voor het op grote schaal opener maken van het weidevogellandschap. Mede, omdat predatieniveaus sterk variëren over de jaren.*

*Volgens de provincies worden opgaande vegetaties op relatief kleine schaal afgezet (in weidevogelkerngebieden en het omliggende grasland). De Flora- en Faunawet beperkt het verwijderen van bestaande vogelnesten. Daarnaast is het verwijderen van opgaande vegetatie beperkt vanwege cultuur historische waarde, Natura 2000 aanwijzing, Boswet en de APV kapregulatie. Houtkap vergunningen kunnen worden verleend na overweging van verschillende belangen.*

*Niet kwetsbare roofvogelsoorten die in heel Nederland voorkomen, en vooral de soorten met hoge dichtheden, zullen zich bij afname van hun leefgebied zeer waarschijnlijk kunnen verplaatsen en handhaven in de omliggende gebieden. Voor de relatief zeldzame soorten zoals de Kiekendieven en Purperreiger is het belangrijk om de populatie nauwkeurig te monitoren. Daarnaast heeft het op grote schaal verwijderen van riet mogelijk negatieve effecten op populaties van de Bruine Kiekendief en veel rietbewonende zangvogels. Het verwijderen van riet kan ook een tegenovergesteld (positief) effect hebben op predatie, aangezien riet een leefomgeving biedt voor alternatieve prooien zoals Meerkoeten en eenden. Het is daarom belangrijk om niet al het riet in de omgeving weg te maaien. Bovendien is het belangrijk om muizenrijke plaatsen te creëren als een alternatieve voedselbron voor deze roofvogels. Wanneer deze plaatsen op een strategische wijze buiten het weidevogelgebied zijn geplaatst zal dit mogelijk de predatiedruk in het gebied verlagen.*

*Kortom, meer inzicht is nodig in de effecten van het opener maken van landschap op roofvogels en op de blauwgroene dooradering van opgaande vegetatie in Nederland. Dit inzicht is nodig om fragmentatie van gebieden met een opgaande vegetatie te voorkomen, zodat een eventuele ineenstorting van populatieaantallen van soorten kan worden voorkomen. Daarom moeten de effecten van een vergrootte openheid in weidevogelgebieden op roofvogels nauwkeurig worden gemonitord en raad ik aan om het verlies van opgaande vegetatie te compenseren met een versterking van de blauwgroene dooradering.*

## **Abstract**

*Between 1990 and 2011, of the bird species groups from Europe the largest decline is observed for wader species. Since the Netherlands harbors a relatively large proportion of the global population of these wader species, it has a responsibility for their persistence. Designated, as one of the major negative influences on meadow bird breeding success is a decrease in openness, which is related to an increase in predation. In order to reduce predation, reed, brushwood and potential nesting trees for the Common Buzzard, Northern Goshawk, Sparrowhawk, White Stork, Grey Heron and Kestrel are removed from meadow bird breeding area. In this review I addressed the following question: What are the necessity and the effects of removing tall vegetation (reed and woody plants) from Dutch meadow bird areas on waders and avian predators? Here I reviewed scientific and grey literature and identified knowledge gaps.*

*Increasing the openness of meadow bird areas will possibly have positive effects on meadow bird populations. Since wader populations are still decreasing negative impacts on their reproductive success should be improved. However, many other factors contribute to the negative trends of wader populations, such as water level, mowing date and herbal diversity. Since tall landscape elements such as in the green-blue network (in Dutch 'groenblauwe dooradering') have several ecological functions and many species depend on them I would recommend to improve other important habitat demands before a large-scale increase of openness in meadow bird areas. Especially, since predation levels are highly variable over years.*

*According to the provinces, management of tall vegetation is done on a relatively small scale (in meadow bird core areas and surrounding grassland areas). The Flora- and Fauna Act regulations restrict the removal of existing bird nests and removal of tall vegetation is restricted by cultural historical value, Natura 2000 designation, Forest Act and APV log regulation. Logging permits may or may not be granted after consideration of various interests (including the openness benefits for meadow birds).*

*Not vulnerable avian predator species that are distributed throughout the Netherlands will, when tall vegetation is lost from the area, possibly be able to relocate to surrounding areas. For relatively rare species such as the Harriers and Purple Heron it is important to monitor population differences closely. The large-scale removal of reed might have negative effect on Marsh Harrier populations and many reed inhabiting singing birds. Removing reed can also have reverse (positive) impact on predation, since reed provides habitat for alternative prey (Coots, ducks). It is therefore important not to mow all reeds in the (meadow bird) area. It is also important for the conservation of these species to create vole rich places as an alternative food source. When these places are located strategically outside the meadow bird area this will most likely lower predation pressure in the area.*

*In short, more insight is needed in the effect of increasing openness in meadow bird areas on the green network of tall vegetation in the Netherlands. This is needed in order to prevent fragmentation of tall vegetation areas, which might lead to a collapse in population numbers of many species (not only avian predators). Therefore, the effects of increased openness in meadow bird areas should be carefully monitored and compensation of the loss of tall vegetation by strengthening the green network is recommended.*

## **Preface**

A review on scientific and grey literature about the influence of increasing the openness in meadow bird areas on waders and avian predator populations. This review is as part of the master thesis, programme Environmental Biology, track Ecology & Natural Resource Management at Utrecht University. The time schedule for this thesis was 7,5 ECT: five weeks.

## **Introduction**

Designated as one of major negative influences on meadow bird breeding success is a decrease in landscape openness, which is related to an increase in predation (Teunissen *et al.*, 2012; Duijns *et al.*, 2009). Openness is defined as the part of an area free of disturbance of landscape elements following so called disturbance distances (distance from trees, shrubs, buildings e.g., where less breeding pairs are present than without these disturbance source) (Oosterveld, 2011). In order to reduce predation, the province of Friesland removes brushwood and potential nesting trees of the Common Buzzard, Northern Goshawk, Sparrowhawk, White Stork, Grey Heron and Kestrel from meadow bird breeding area (Oosterveld, 2011). The question is: Do positive effects of removing brushwood and trees from Dutch meadow bird area on waders outweigh the negative effects on avian predators?

Meadow bird species can be subdivided into two subcategories: primary and secondary species. Primary species nest predominantly in grassland area. Secondary species only nest occasionally, or locally in grassland area (Verstrael, 1987 in Beintema *et al.*, 1995). For many people meadow birds, especially the wader species Black-tailed Godwit (*Limosa limosa L.*), Common Redshank (*Tringa tetanus*), Northern Lapwing (*Vanellus vanellus*) and the Eurasian Oystercatcher (*Haematopus ostralegus*), belong to the classic image of the Dutch pasture landscape. However the use of artificial fertilizers, the maintenance of lower water levels, intensified grazing, advanced mowing, higher mowing frequencies and the increase of large grassland monocultures have caused that the drastic decline of meadow bird populations over the last century (Beintema *et al.*, 1995). Between 1990 and 2011, the largest decline is observed for wader species (Teunissen & van Paassen, 2013).

In the year 2000, thirty percent of the European Oystercatcher population and 10% of the Lapwing population was dependent on Dutch breeding areas (Teunissen & Soldaat, 2006). Since the Netherlands harbours a relatively large proportion of the global population of these wader species, it has from European perspective a responsibility for their persistence. Especially since in Europe meadow birds is the avian species group that declined most (20% since 1990) (Teunissen & van Paassen, 2013). Therefore, as reaction to the decline of meadow bird populations traditionally managed reserves were established in order to protect endangered species, such as Ruff and Common Snipe (Teunissen & Soldaat, 2006). However, most meadow bird species breed in agricultural land (Teunissen *et al.*, 2005). Specific regulations arose, such as establishing nest protectors and delayed mowing, which should positively affect meadow bird breeding success (Beintema *et al.*, 1995; Teunissen *et al.*, 2005). Although, these management activities did have positive effects (Teunissen, 2000) meadow bird populations were still declining (Kleijn *et al.*, 2001). Therefore people became to realize that many eggs and young birds were lost due to other factors than agricultural activities. Predators are often held responsible for these losses (Teunissen *et al.*, 2005). Several species have been identified as meadow bird predator. Mammal predators of meadow birds are the Red Fox (*Vulpes vulpes*), several Mustelidae species (Weasel, Marten, Polecat, Ermine), Hedgehog, Cat and Dog (van der Vliet, *et al.*, 2008; Teunissen *et al.*, 2005). Also several avian predators eat meadow birds.

Predation is one of the natural mechanisms in controlling population size. It is a selection force taking away weak individuals, keeping up a natural balance in which strong individuals survive. Since many birds produce more eggs than needed to maintain the species, population dynamics seem to be adapted to

predation as a regulating factor (Teunissen *et al.*, 2005). Although, when other factors disturb this natural balance, predation might be the last straw for meadow bird species.

In order to reduce meadow bird predation it is often recommended to safeguard the openness of the landscape, in other words remove trees and bushes. This would prevent avian predators from breeding in the area, makes them more visible for meadow birds and takes away their viewing points (van der Vliet *et al.*, 2008; Teunissen *et al.*, 2005). However, this might have negative consequences for these avian predators. This is particularly worrying since some of these species show declining numbers. In this thesis I therefore focus on answering the following question: What are the necessity and the effects of removing tall vegetation (reed and woody plants) from Dutch meadow bird areas on waders and avian predators? In part one, meadow birds waders are described with their protection statuses, trend, habitat requirements and measures taken in order to protect them. In the second part, species predated on meadow birds, their protection statuses, breeding habitat, trends, disturbances and measures taken against predation are described. In the discussion I combined the above-described information by identifying overlap in habitat requirements (landscape configuration: vegetation, buildings etcetera), diet preferences and foraging behaviour of avian predators and wader species distributions.

## **1. Meadow Birds**

### ***Protection status:***

In the Netherlands 28 species are considered meadow birds, of which 15 are included in the Dutch Red List of 2004 (table 1). Of the primary species two have the status nearly threatened, five species are vulnerable, the Common Snipe (in Dutch Watersnip) is endangered and the Ruff is critically endangered. Of the secondary species four have a vulnerable status and two have an endangered status (Vogelbescherming Nederland, 2013). Only one species is on the IUCN Red List, the Black-tailed Godwit with a near threatened status. Common snipe and Black Tern are not yet assessed for the IUCN Red List (IUCN Red List, 2013).

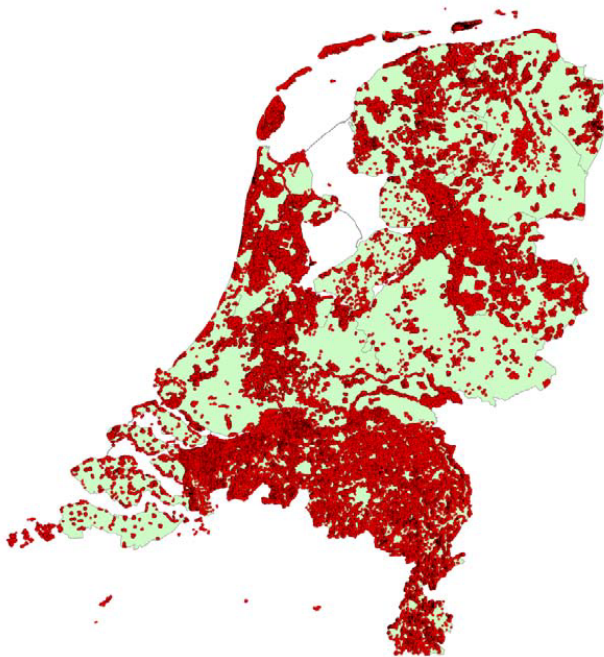
**Table 1.** Primary and secondary meadow bird species. In green: near threatened, yellow: vulnerable, orange: endangered, red: critically endangered (based on Beintema, Moeds & Ellinger, 1995)

<b>Primary species</b>	<b>Secondary species</b>
<b>Black-tailed Godwit – <i>Limosa limosa</i></b>	Black-headed Gull – <i>Croicocephalus ridibundus</i>
Blue-headed Wagtail – <i>Motacilla flava</i>	Black tern – <i>Chilidonias niger</i>
Common Snipe – <i>Gallinago gallinago</i>	Common Tern – <i>Sterna hirundo</i>
<b>Curlew – <i>Numenius arquata</i></b>	Coot – <i>Fulica atra</i>
Garganey – <i>Anas querquedula</i>	Corn Bunting – <i>Miliaria calandra</i>
<b>Lawping – <i>Vanellus vanellus</i></b>	Corncrake – <i>Crex crex</i>
Mallard – <i>Anas platyrhynchos</i>	Gadwell – <i>Anas strepera</i>
Meadow Pipit – <i>Anthus pratensis</i>	Grey Partridge – <i>Perdix perdix</i>
Northern Shoveler – <i>Anas clypeata</i>	Pied Avocet – <i>Recurvirostra avosetta</i>
<b>Oystercatcher – <i>Haematopus ostralegus</i></b>	Quail – <i>Coturnix coturnix</i>
<b>Redshank – <i>Tringa totanus</i></b>	Shelduck – <i>Tadorna tadorna</i>
Ruff – <i>Philomachus pugnax</i>	Stonechat – <i>Saxicola rubicola</i>
Skylark – <i>Alauda arvensis</i>	Teal – <i>Anas crecca</i>
Tufted Duck – <i>Athya fuligula</i>	Whinchat – <i>Saxicola rubetra</i>

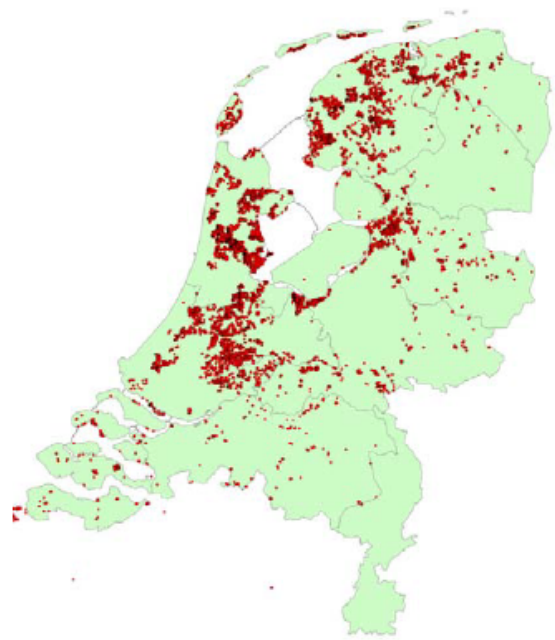
### ***Change in breeding pair numbers***

In general the numbers of Godwit, Redshank, Lapwing and Oystercatcher have been declining over the last twenty years. Oystercatcher numbers are continuously declining since 1990 with a yearly decrease of 3% of the population. Godwit numbers show the same pattern (yearly decrease of 2%), although with small revivals around 1994 and in 2010-2011. Lapwing numbers did not start to decline until 1995. Currently, 80% of the original population of 1990 is left. Redshank numbers remained relatively stable: they declined since 2000, but show a recent revival (Teunissen & van Paassen, 2013). In the period of 2007-2011 Godwit and Lapwing had a slight average increase (Teunissen & Calijn, 2013).

There was a recent revival of meadow birds between 2007-2011 in all area types: Northern fens, North-Marine clay, sandy soils, Western fens, River area and Southern Marine clay. In the first four areas an increase in meadow bird numbers, in the last two a smaller decrease. Tufted Duck, Quail and Yellow Wagtail were already increasing, but increase stronger than before. Shoveler, Lapwing, Godwit and Meadow Pipit shifted from a decrease to an increase. Oystercatcher and Skylark are declining less steeply and Teal and Garganey are decreasing with increasing speed. The revival is not seen as a turnaround, since until now revivals have been followed by renewed declines (Teunissen & Calijn, 2013).



**Figure 1.** Meadow bird territories in 2009 (Teunissen *et al.* 2012)



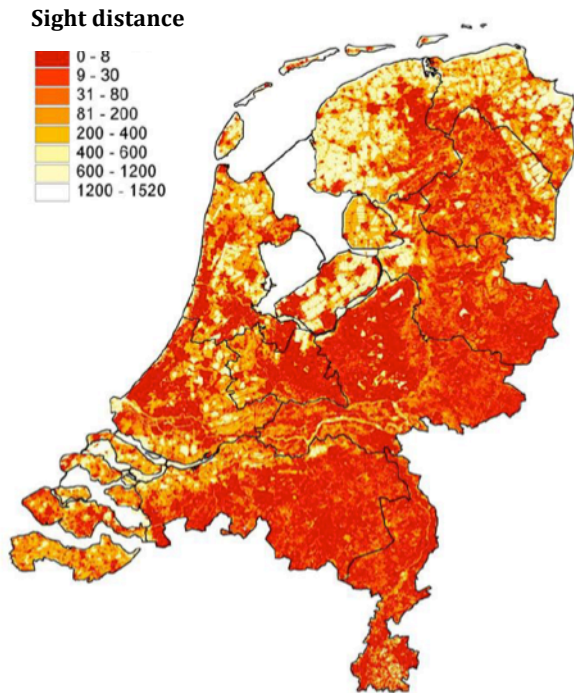
**Figure 2.** Godwit territories 2008-2011 (Teunissen *et al.*, 2012)

### ***Habitat requirements and management***

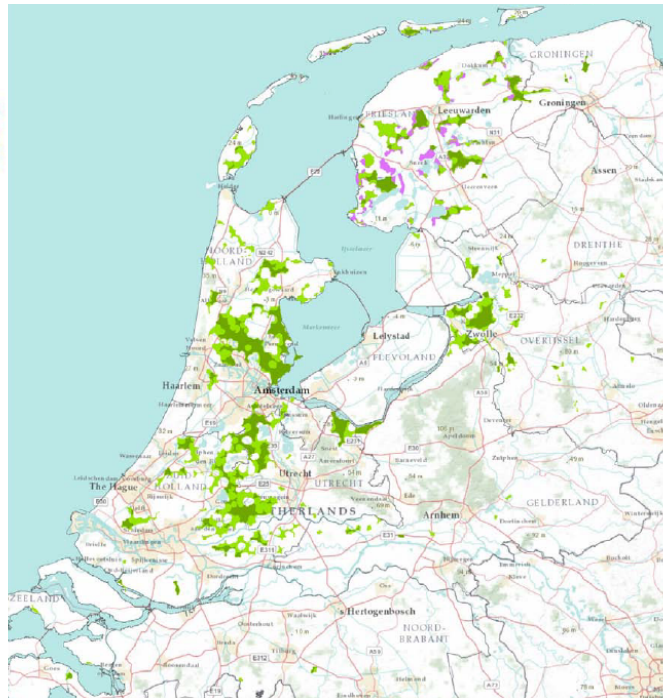
The territories of all meadow bird species together are spreaded throughout the Netherlands (figure 1). Godwit and other wader species territories occur less widespread, and are found mostly in North- and West-Netherlands (figure 2 and figure 5). It is assumed that areas with a sustainable Black-tailed Godwit number are also suitable for Lapwing, Oystercatcher, Redshank and probably many other meadow bird species (van 't Veer *et al.*, 2010). Based on comparison of these areas with other areas the following characteristics are important: high degree of openness (minimal 600 meters sight; figure 3), winter water level of maximum 25 cm below surface level in



peat areas and of maximum 25 cm in clay on peat areas 35 cm and in clay areas 50 cm, herb rich grassland not mown until June 15<sup>th</sup> and distance to highways is minimal 300 meters (Teunissen *et al.*, 2012).



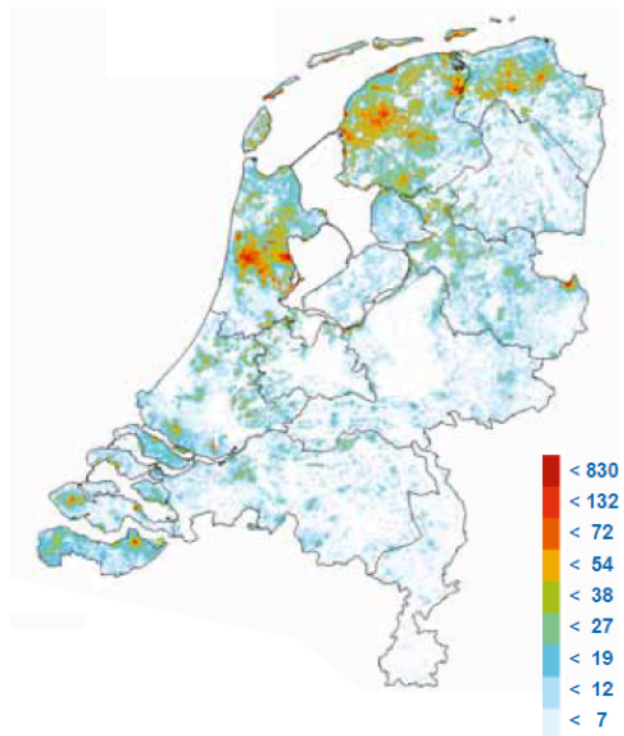
**Figure 3.** Sight distance in meters (Jochem & Meeuwssen., 2011)



**Figure 4.** Core areas with >15 Godwit breeding pairs/ 100 ha (light green) or > 30 breeding pairs/ 100 ha (dark green) (Teunissen *et al.*, 2012).

Meadow birds can be subdivided into three subgroups based on their habitat demands. These subgroups are the 'very critical' species, 'critical' species and the other characteristic meadow and field birds (Laporte & de Graaff, 2006).

The habitat of the very critical species (Ruff level: Snipe, Ruff, Garganey and Shoveler) is higher salt marshes and seepage areas in the lower reaches of river (Laporte & de Graaff, 2006; Oosterveld, 2011). They require marshy grassland with a spring water level of 0-20 cm below surface level that does not decrease under 45-60 cm until and during May/June (Oosterveld, 2011; van 't Veer *et al.*, 2008). The optimal 'Ruff' habitat contains many herbal species, is open and has a large variation in wet to dryer areas, is late mown, extensively grazed and has slough puddle plots. The long grass provides insects and protection of chicks against predation.



**Figure 5.** The distribution of waders in the Netherland (Teunissen & Paassen, 2013)

Management consists of a mosaic of measures of extensive grazing, moderate fertilizing, liming and mowing spread over a time period from end May to the start of July. Nest protection is done wherever it is needed. The area has a high water level (40 cm) and has partly wet parcels during winter and/or spring: natural slough puddles, in Dutch *plas-dras* (Laporte & de Graaff, 2006).

Critical meadow bird species (Black-tailed Godwit, Lapwing and Redshank) require a spring water level (March/April) of 20 to 40 cm below surface level, which does not decrease less than 45 to 60 cm below surface level in the course of May/June (Oosterveld, 2011; Kleijn *et al.*, 2009; van 't Veer *et al.*, 2008). They live in landscapes characterized by openness (figure 3), wet plots in spring, a mosaic of grazing, early to late mowing and other forms of less to more extensive agricultural management. Nest-protection takes place wherever it is needed. Management consists of a mix of measures leading to an optimal variation of long grass during the breeding season of April to June. Measures consist of staggered mowing (in Dutch: *maaitrappen*) in May, delayed mowing dates in June, prior grazing, extensive continued grazing, flight parcels and/or broad parcels with delayed mowing dates (Laporte & de Graaff, 2006).

The other species characteristic for meadows and fields are Lapwing, Oystercatcher, Skylark, Yellow Wagtail and Partridge (Laporte & de Graaff, 2006). They have a habitat characterized by openness. In contrast to Black-tailed Godwit these species do not need long grass in order to survive. Next to standard agricultural proceedings volunteered nest protection is the most important management measure for these species. Additional management can be of value for species such as Skylark, Partridge, Pipit and Montagu's Harrier on fallow plots (Laporte & de Graaff, 2006).

### **Core area based protection**

After evaluation of meadow bird protection by the 'knowledge network meadow bird landscape' (*kenniskring weidevogellandschap*) the concept of meadow bird core area protection arose. The idea is that optimizing meadow bird management effort in smaller areas that harbour a large proportion of the population has better effects than spreading conservation efforts. Cluster analysis based on recent field data of a large scaled meadow bird inventory in Noord-Holland showed that a high overall meadow bird diversity often goes hand in hand with high Black-tailed Godwit densities (van 't Veer *et al.*, 2010). Therefore Black-tailed Godwit was seen as the indicator species to base management efforts on. Black-tailed Godwit core areas with more than 15 pairs per 100 ha (figure 4) contain also one-third of the Shovelers and Redshanks and one-fourth of the national Oystercatcher population. For other populations these densities are much lower and breeding areas of these species are mostly outside these Black-tailed Godwit core areas. When using the core areas with more than 30 pairs of Godwits per 100 ha (figure 4) the importance of these areas for other species decreases sharply. For the other meadow bird species are thus additional management measures needed (Teunissen *et al.*, 2012).

Van 't Veer *et al.* (2008) determined that well functioning stable meadow bird areas have a minimal extent of 30-70 ha (on average 50 ha), which need optimal meadow bird management. These areas are surrounded by a buffer of open grassland area without disturbance of roads, trees and buildings. This surrounding open area can also exist of water. When a buffer of 250 meters as disturbance-contour around the area is used (neutralizing the disturbing effect of trees), including buffer the minimum size of a stable meadow bird area is 132-164 ha (van 't Veer *et al.*, 2008). The buffer area has an important ecological role in lowering predation pressure and human disturbance in core areas. The (buffer) grassland area, that has normal agricultural management, also has an important role as foraging area. The intention is that sufficient slough puddle spots are present, which meadow birds can use in dry springs. In winter these

grasslands can be used as foraging site for migrating and wintering waders and ducks (Teunissen *et al.*, 2012).

An optimal Godwit biotope can harbour breeding densities of 20-30 pairs per 100 ha. With this in mind a minimum area size would be 170-250 ha. Godwit areas with this size do not necessarily have to be part of a meadow bird core area network (Teunissen *et al.*, 2012). Therefore, Teunissen *et al.* (2012) determined 250 ha as a lower threshold for core areas.

## **2. Avian predators**

### ***Species preying meadow birds***

So, which birds prey on meadow birds in the Netherlands? Many avian predator species are seen in the Dutch meadow landscape (table 2). However, not all of these species prey on meadow birds.

Corvids, such as Common magpie (*Pica pica*) and Carrion Crow (*Corvus corone*) prey on eggs and chicks. In the study of Teunissen *et al.* (2005) Carrion Crows were responsible for 3% of the on camera recorded nest predations and for 6% of the chick predations (Teunissen *et al.*, 2005; Schekkerman *et al.*, 2009).

The Common Kestrel predated on little singing birds such as Skylark. Adult wader species are too large to be a prey, but kestrels do eat their chicks (<2% of total predation; Teunissen *et al.*, 2005; Schekkerman *et al.*, 2009). Buzzards were responsible for 12% of the chick predation and the Northern Goshawk for <2%. Both species are also able to prey adult meadow birds (van der Vliet *et al.*, 2008; Teunissen *et al.*, 2005). Starvation risk of adult individuals can lead to a higher predation mortality. Food availability is higher near a (raptor concealing) covered area. Also, flock forming, which makes Redshanks less vulnerable for predation, brings intra-specific food competition. Because of higher starvation risks in winter Redshanks are, therefore, forced to take more predation risks. Predation by Sparrowhawks increases with smaller Redshank population sizes (Cresswell & Whitfield, 2008).

Grey Herons were in the Netherlands responsible for 8-18% of the chick predation (Teunissen *et al.*, 2005; Schekkerman *et al.*, 2009). Also, White Storks were observed to eat meadow bird chicks (Teunissen *et al.*, 2005). Lapwing chicks are preferred as prey over Godwit chicks. Furthermore, Gulls predate on chicks, just as Sparrowhawk and the Harriers (Teunissen *et al.*, 2005; Vogelbescherming Nederland, 2013). Harriers, Kestrel, Peregrine Falcon, Hobby, Sparrowhawk and Merlin also hunt on small (singing) birds (Vogelbescherming, 2013).

### ***Magnitude of predation***

The national study of Teunissen *et al.* (2005) in the breeding season of 2000 and 2004 (159000 nests) gives an impression of the magnitude of predation losses of meadow bird eggs, chicks and adults. During this study it rarely occurred that predators ate adult waders. Only two adults were eaten; one by a fox and one by a Common Buzzard. In areas with nest protection predation was the main cause of egg losses and explained 80% of the variation in hatching numbers. Between 24 and 27% of the eggs were eaten by predators, 21-22% was lost due to other causes. Mammals more often ate meadow bird eggs than avian predators. Only few of the hatched chicks reached the age of fledging (on average 7% of the Godwits and 14% of the Lapwings). The predation level of chicks was estimated to be between 50 and 70%. This number includes missing chicks and found tags and remains of chicks. It is important to realise that this last category contains actively predated, but also scavenged chicks (Teunissen *et al.*, 2005). In addition a British study on Lapwings showed that the tags are not able to withstand the digestive system of mammals such as Foxes and Cats. This implies that although,

avian predators seemed to have a 2-4 fold larger share in chick predation in reality mammals have a much larger share (Jonge Poerink, 2009). Mammals had a larger share in egg predation. In open areas (Lapwing areas) 80% of predation occurred by Aves and in areas with lengthy grass (Godwit area) mammals were the most important predators. Predation pressure was smaller in areas with increasing openness, although Teunissen *et al.* (2005) found no relation between openness and the number of predators. Egg survival was highest in the early breeding season (until start of May) (Teunissen *et al.*, 2005).

So, predation seems to have considerable impact on egg and chick survival. Chick predation, in which Aves contribute most, has the largest negative impact on reproduction success. Predation pressure is smaller with increased openness and early in the breeding season.

**Table 2.** The food relation of avian predators with wader species (X), \* means that only small singing bird adults are eaten (based on Teunissen *et al.* (2012); Vogelbescherming Nederland (2013); van der Vliet *et al.* (2009) Hoppstadter *et al.*, 2007 in Jonge Poerink (2009)

Avian predators	Eggs	Chicks	Adults
Marsh Harrier	X	X	*
Hen Harrier		X	*
Montagu's Harrier			*
Common Buzzard	X	X (Godwit)	X
Kestrel		X	*
Peregrine Falcon		X	X
Hobby			*
(Northern) Goshawk	X	X	X
Sparrowhawk		X	*
Merlin			*
Raven	X	X	
Carrion Crow	X	X	
Jackdaw	X	X	
Rook	X	X	
Common Magpie	X	X	
Black-headed Gull	X	X	
Common Gull	X	X	
Herring Gull	X	X	
Lesser Black-backed Gull	X	X	
Grey Heron		X (Lapwing)	
White Stork		X	
Purple Heron			
Black Tern			
Eurasian Oystercatcher	X		

**Table 3.** Food preferences of the avian predator species (Vogelbescherming Nederland, 2013; Svensson, 2010)

Food preferences	Small birds	Large birds	Small mammals	Mice	Rabbits	Cadavers	Invertebrates	Plant seeds	Buds	Human garbage	Eggs	Amphibians	Fish
Marsh Harrier	X		X	X									
Hen Harrier			X	X	X								
Montagu's Harrier	X			X									
Common Buzzard			X			X	X						
Kestrel				X									
Peregrine Falcon	X												
Hobby	X						X						
(Northern) Goshawk	X	X	X	X	X								
Sparrowhawk	X												
Merlin	X												
Raven	X		X				X				X		
Carrion Crow						X	X	X		X			
Jackdaw						X	X	X		X			
Rook						X	X	X	X				
Common Magpie						X	X	X	X	X	X		
Black-headed Gull							X			X			
Common Gull							X						X
Herring Gull							X			X			X
Lesser Black-backed Gull													
Grey Heron			X	X			X					X	X
White Stork			X	X			X					X	
Purple Heron							X					X	X
Black Tern							X						X

**Protection status Avian predators**

Carrion Crow, Marsh Harrier, Northern Goshawk and Eurasian Oystercatcher are not on the Dutch Red List. However, Marsh Harrier and Oystercatcher are protected by the Natura 2000 Act, the Marsh Harrier as breeding bird and Oystercatcher as a wintering bird. Avian predators that are incorporated in the Dutch Red List are Hen Harrier, Montagu's Harrier, Peregrine Falcon, Hobby, Raven, Purple Heron and the Black Tern (Vogelbescherming Nederland, 2013). In the IUCN Red List 2004 all these avian predators have a status of least concern (IUCN, 2013)

### **Breeding habitat**

The only avian predator described that does not breed in the Netherlands is the Merlin, which is a wintering species. Gulls nest in dunes or sand bars along the coast (Vogelbescherming, 2013). Common Kestrels, Peregrine Falcons, Jackdaw, Herring Gull, Lesser Black-backed Gull and White Stork nest on human buildings. Both Gull species nest on flat roof tops, Jackdaws and Kestrels in cavities or niches, Peregrine Falcons on ridges and White Storks on chimneys and roofs (Svensson, 2010; Vogelbescherming, 2013). The other avian predators generally depend on shrubs and trees for nesting. Some species need (old) reeds and others depend on dense vegetation (Vogelbescherming, 2013). Harriers for example nest between vegetation (shrubs, reed, or heath) on the ground (Svensson, 2010). Some species have specific preferences for certain tree species others are more generalists. Northern Goshawks for example have a preference for nesting in coniferous trees and the Common Buzzard nests in large trees (often Larch, Pine or Poplar). The Common Magpie nests in a forked branch high in tall trees or in thorny bushes (Royal Society for the Protection of Birds, 2013). Magpie nests are large and very solid. Therefore, many avian species (Crows, pigeons and sometimes ducks) make use of abandoned Magpie nests. Long eared owl and Common Kestrel even depend on these nests (Baeyens, 1988).

**Table 4.** Breeding habitat of avian predator species occurring in meadows (based on Svensson, 2010; Vogelbescherming Nederland, 2013)

Breeding habitat	Buildings	(old high) Reed	Brushwood	Trees	Electricity pylons	Dunes	Sand bars	Open area	Ground	Heath	Nest boxes	Carrion Crow nest
Marsh Harrier		X	X						X			
Hen Harrier			X			X			X	X		
Montagu's Harrier			X					X	X	X		
Common Buzzard				X								
Kestrel	X			X							X	X
Peregrine Falcon	X				X							X
Hobby				X								X
(Northern) Goshawk				X				X				
Sparrowhawk				X								
Northern Raven				X								
Carrion Crow				X								
Jackdaw	X			X								
Rook				X								
Common Magpie			X	X								
Grey Heron		X		X								
White Stork	X			X	X							
Purple Heron		X		X								
Black-headed Gull						X	X	X				
Common Gull	X			X		X		X				
Herring Gull	X					X		X				
Lesser Black-backed Gull	X					X		X				

**Table 5.** Breeding habitat of Avian predator species, specified on trees (based on Svensson, 2010; Vogelbescherming Nederland, 2013)

Breeding habitat	Tall trees	Hollow trees	Conifereous trees	Deciduous trees	Poplar	Larch	Pine	Spruce	Forests
Marsh Harrier									
Hen Harrier								X	
Montagu's Harrier									
Common Buzzard	X			X	X	X	X		
Kestrel									
Peregrine Falcon									
Hobby									
(Northern) Goshawk									X
Sparrowhawk			X					X	X
Northern Raven									X
Carrion Crow									
Jackdaw				X					
Rook	X								
Common Magpie	X								
Grey Heron									
White Stork									
Purple Heron									

### **Change in breeding pair numbers**

The trend of the number of breeding birds from 1990-2010 differs between the different species of avian predators. The number of breeding birds is decreased for Marsh Harrier, Hen Harrier, Kestrel, Hobby, Jackdaw, Common Magpie, Black-headed Gull, Common Gull, Herring Gull and Grey Heron. No changes are observed for Sparrowhawk and Black Tern and increasing are Montagu's Harrier, Common Buzzard, Peregrine Falcon, Raven, Carrion Crow, Rook, Lesser Black-backed Gull, White Stork, Purple Heron and Mute Swan. The small number of breeding pairs in 1990 can explain breeding bird increases of many of these species. In the past persistent toxic substances, such as DDT, had strong negative effect on population numbers of many predator species. Therefore, the ban of DDT in 1973 had positive effect on the numbers of many avian predators species. Herons have benefitted from soft winters and increasing water quality of the last decennia (Teunissen *et al.*, 2005). Montagu's Harriers were at the start of 20<sup>th</sup> century one of the main occurring birds of prey in the Netherlands. Agricultural intensification, the use of pesticides, large scaled reclamation of uncultivated areas and the closing of open areas resulted in Montagu's Harriers being one of the rarest breeding birds in the Netherlands. In the nineties all three Harriers species profited of the large scaled multiannual fallow area that arose from production excluded fields in Groningen. Montagu's Harriers came back as breeding bird in the Netherlands (Koks & van Scharenburg, 1997). The Rook was hunted commissioned by farmers and the Purple Heron was actively prosecuted at the beginning of the 20<sup>th</sup>

century (Vogelbescherming Nederland, 2013). Also, around the seventies many in water feeding bird populations (such as White Stork) decreased considerably because of water pollution (Ruitenbeek, Scharringa & Zomerdijk, 2012; den Boer, 2000).

### ***Disturbances***

The Harrier species are sensitive for disturbance during the breeding season. Hen Harrier populations decline because of vulnerability of marshland and dune slacks. The Montagu's Harrier is sensitive for a decrease in suitable breeding area by changes in agriculture. The Harrier species needs developing brushwood on grain fields or long-term fallow fields and nest protection. Some avian predators are eaten by Northern Goshawks (Hobby, Sparrowhawk and Common Magpie, Common Buzzard; Vogelbescherming Nederland, 2013; Kruger, 2004). Walking or jogging humans can also disturb Buzzard nests (Kruger, 2004). Decreases in abundances might be related to this predation by Goshawks. Purple Herons are disturbed by predation of Foxes and Magpies suffer from declines in insect densities (Vogelbescherming Nederland, 2013). In urban areas breeding Rooks are increasingly faced with disturbance (van Dijk, *et al.* 2010). With increased area covered by buildings nest occupancy of Grey Herons decreases (Jakubas & Epowronska, 2013).

### ***Openness***

Avian predators of wader species (e.g. falcons) use structures such as high vegetation, hills or dikes covering their approach to prey (Bijlsma 1990 in Duijns *et al.*, 2009). Hunting success of these predators is higher at locations with cover compared to open landscapes. This suggests that predation risk for meadow birds declines with the distance from cover. Furthermore, differences exist in foraging strategies of two Bar-tailed Godwit sub-species. The energy minimiser *Limosa lapponica* took less risk than *Limosa taymyrensis* that foraged in food-rich areas nearby cover (Duijns *et al.*, 2009). These different foraging strategies might be also applied by the wader species discussed here. The spatial scale of structural landscape influences varies with territory size and distances of foraging trips of a species during the breeding season. This means that the presence of landscape elements (e.g. pastures and farmyards) has differential disturbance distances for different species (Soderstrom & Part, 2000). The minimal openness (average sight distance) for Godwits is 400 meters and above 600 meters is ideal (Sierdsema *et al.*, 2013). For Lapwing, Oystercatcher and Godwit maximum disturbance distances of tree covers are assumed to be between 100 and 350 meters from nests (van der Vliet *et al.*, 2010). A house or village edge has a maximum disturbance distance between 150 and 1200 m. and a highway depending on the noise and species has a disturbance distance between 120 and 2100 m (van der Vliet *et al.*, 2010).

Meadow birds seem to avoid predators by choosing their nesting sites away from nests of Carrion Crow and Buzzard. They also prefer open landscapes, probably because of a high predator visibility. Aggressive species such as Lapwing probably nest in open landscapes to early detect avian predators and extrude them (van der Vliet *et al.*, 2008). Small singing birds such as the Eurasian Skylark make use of the aggressive character of Lapwings and nest between them as protection against predators (van de Vliet *et al.*, 2008).



**Figure 6.** Threats for the avian predator species (Vogelbescherming Nederland, 2013; Reijen *et al.*, 1995; van Dijk, *et al.* 2010; Jakubas & Epowronska, 2013; Kruger, 2004

Threats	Vole decrease	Hawk predation	Severe winters	Dry winters	Competition	Drying of wet heaths	Disturbance breeding	Insect decrease	Intensified agriculture	Traffic
Marsh Harrier	X									
Hen Harrier	X						X		X	
Montagu's Harrier	X						X			
Common Buzzard										X
Kestrel										
Peregrine Falcon										
Hobby						X				
(Northern) Goshawk										
Sparrowhawk		X								
Merlin										
Raven										
Carrion Crow		X								
Jackdaw										
Rook							X			
Common Magpie		X			X			X		X
Black-headed Gull										
Common Gull										
Herring Gull										
Lesser Black-backed Gull					X					
Grey Heron			X				X			
White Stork										
Purple Heron				X						
Mute Swan										
Black Tern										
Oystercatcher										

### **Policy regarding predators**

In the meadow bird covenant (in Dutch 'Weidevogelverbond') nationwide relevant actors agreed upon protection of meadow bird areas against fragmentation, disturbing of peace and openness, low water levels and disturbance by traffic and agricultural activities. The aim was to halt the decrease of meadow bird populations by 2010 and eventually a sustained population of the Black-tailed Godwit as a model species. In total 250.000 ha would be realized for critical species, 450.000 ha for less critical species and

30.000 ha for the very critical species (Laporte & de Graaff, 2006). By law (article 65.1) it is allowed to hunt Foxes (*Vulpes vulpes*), Rooks and Carrion Crows (*Corvus corone corone*). These are general occurring species, which provide across the country a frequent threat to protected meadow bird species (Ministry of Economical Businesses, Agriculture and Innovation, 2013). Further, it is established in article 9, 10 and 11 of the Flora & Fauna Act that hunting native bird species, or removing or disturbing birds of prey nests during the breeding season is prohibited (De wegwijzer naar informatie en diensten van alle overheden, 2013). Within the boundaries of the law it is assigned to the provinces to reduce predation pressure on meadow bird populations to an acceptable level. This is done in an area based approach in order to maximally stimulate and facilitate operators and mutual cooperation. The predation management plan of the meadow bird area around Idzegea in Friesland (Jonge Poerink, 2009) is seen as a good example of how predation management can be applied (Oosterveld, 2011). The Province Friesland incorporated this in meadow bird landscapes policy by removing up-going landscape elements, reed, brushwood (originating bushes, trees and reeds) and potential nesting trees for the Common Buzzard, Northern Goshawk, Sparrowhawk, White Stork, Grey Heron and Kestrel from meadow bird breeding area (Oosterveld, 2011). However, these preventative measures are restricted by regulations such as the Forest Act, Natura 2000 agreements, Flora- and fauna act and the APV log regulation. In meadow bird reserves of the Province Limburg State Forestry (Staatsbosbeheer) cuts short thickets every four years. Thicket removal is done in order to maintain the openness and to prevent Carrion Crow, Magpie, Jay and Buzzard from establishing in the reserves. The removed thickets consist inter alia of Black Cherry (*Prunus serotina*), Oak (*Quercus robur*), Buckthorn (*Rhamnus frangula*) and European Aspen (*Populus tremula*). This is also done in Utrecht and Overijssel with additional removal of trees, reed and brushwood in meadow bird grassland area (when there are no restrictions by law). Reed is mown every 1-3 year. In the meadow bird conservation area de Ronde Hoep in Noord-Holland potential nesting trees of mainly Buzzard, Goshawk and Carrion Crow are removed from the area. Thickets from bushes that in the past contained decades old trees are now cut short every three to four years. Reed fringes are mown every winter. The managed bushes and reed cover about 1% of the meadow bird area (Appendix: questionnaire among Provinces and managers, 2013).

### ***Predation management plan Idzegea Friesland***

Skriezekrite Idzegea is a meadow bird core area of 1675 hectares in South-West Friesland. The soil type is low peatland with a layer of clay on top. Openness, expansion and many puddles and lakes surrounded by old reedbeds characterize the area. Part of the area is assigned as Natura 2000 Goose foraging area. In 2008 1150 breeding couples were counted in the areas, of which 400 Godwit pairs. Jonge Poerink used predation studies of Teunissen *et al.* (2005) and Hoppstadter *et al.* (2007) as an indication of the predation impact and the main predators of meadow birds. In the last decennia the number of the main predators increased in the area. Together with the decrease in meadow birds this has led to a substantial increase in predation pressure. Therefore the main predators were targeted for management. These predators were selected based on the two predation studies and their occurrence in the area. The selected species were Fox, Ermine, Common Buzzard, Grey Heron, Carrion Crow and Marsh Harrier. The following preconditions are set: predation management only within the boundaries of the law, no socially unacceptable impairment of animal wellbeing, not impairing of (characteristic and typical regional) farmyard vegetation. Since this thesis is directed to avian predators I will only mention regulations targeting the management of avian predators (Jonge Poerink, 2009).

To prevent new establishments potential nesting trees, bushes and viewing points of Buzzards and Carrion Crows are removed. Since Buzzards might use the same

nest from year to year it is even in winter prohibited to remove Buzzard nests or trees with Buzzard nests in it (Jonge Poerink, 2009).

Four Grey Heron colonies are present within a foraging distance of the meadow bird breeding area (in total 205 breeding pairs). Since it is forbidden to kill Grey Herons or to disrupt their nests (Flora- and fauna Act) it is a difficult predator species to influence. However, in order to reduce feeding on meadow bird chicks it might be a solution to provide alternative food sources outside the meadow bird core area. Alternative food sources can be additional mice rich sites nearby the Heron colonies or providing with one-day chicks. More information about the creation of mice rich fields is in the original management plan (Jonge Poerink, 2009).

Furthermore, Carrion Crows are controlled by nest removal, shooting adults and fledged youngsters, or crow cage traps with food and a tame or artificial Crow. Further regulation is described in order to prevent the removal of nests, which are occupied by other (by Flora- and fauna Act protected) species. This regulation also prevents the accidentally killing of other inhabitants of the nest. Law prohibits the crow cage trap, since it is non-species selective. However, deputed States of the Province has the authority to grant exemption when there is a good reason for using these traps. In Idzegea for example is restricted in hunting because of its designation as N2000 goose foraging area. In addition it is recommended to farmers to cover up corn pits and waste since they provide food sources for crows. These food sources attract crows and help them through the winter (Jonge Poerink, 2009).

The Marsh Harrier is a relatively rare species in the Netherlands (1500 breeding pairs) and Idzegea provides the habitat for 15 of these breeding pairs. Therefore measures only aim a reduction in predation pressure and not a decrease in Marsh Harrier numbers. Jonge Poerink advised to mow old reed adjacent to locations with high densities of foraging meadow birds and their chicks. Rigorous mowing of reedland is not recommended (maximum 50-70%) since would negatively affect other reed inhabiting bird species. Additionally, reed zones provide alternative food sources (ducks, goose, coots) for predators. The creation of mice rich sites might also reduce predation pressure on meadow birds. It is also important to monitor hare numbers and prevent excessive hunting (Jonge Poerink, 2009).

It is also important not to mark nests with sticks. These sticks are seen by some predator species (e.g. crows) and used as indication of nest locations. It is also important to improve the food availability of meadow bird chicks. Chicks with a higher food availability will have a better body condition, which might lower the chance of being predated. Also, improved mowing management might reduce predation. When during mowing more uncut area is left around nests, the chance of predation decreases (Schekkerman, 2008).

Logging is not allowed in the breeding season and trees in N2000 areas require special attention. Especially high trees, such as White Willow are potential nesting sites for Buzzards. Gray Willow is spherical and remains low. Therefore it is not a very common breeding site for birds of prey, but it is important for small singing birds (Jonge Poerink, 2009).

### ***Compensation for predator habitat***

Compensation for predator habitat outside meadow bird core areas seems to be absent (Questionnaire among Provinces and Meadow bird management organisations, 2013). Also, effects of opening meadow bird areas on avian predator populations are not specifically monitored, although standard monitoring occurs on many bird species including the mentioned avian predators (Ministry of Economical Businesses, Agriculture and Innovation, 2013).

### **Avian predator protection**

All native bird species are incorporated in the Flora- and Fauna Act in order to prevent the killing of birds and disturbance of breeding birds. Additionally some species have a higher protection status that is assigned by the European Union and incorporated in the Bird Directive of the Natura 2000. This directive obliges the Netherlands (and all other countries of the EU) to protect the incorporated bird species and the conservation and restoration of habitats and biotopes. Some of the predator species incorporated in this act are White Stork, Grey Heron, Purple Heron, Marsh Harrier, Hen Harrier, Montagu's Harrier, Sparrowhawk, Black Tern and White Egret. So, this means that the Netherlands is obliged to protect their living area in the therefore assigned areas. Additionally, the Habitat Directive obliges the protection and restoration of important habitat types, such as different kinds of forest wet heath etcetera. The Dutch bird conservation organisation (Vogelbescherming Nederland) protects a wide variety of species by placing nest boxes, bird ringing, research on bird mortality, inventories and biotope restoration.

In the provinces Flevoland, Drenthe, Groningen and Friesland and Overijssel Farmers help to protect Montagu's Harrier nests in (cereal) fields. In Flevoland and Groningen special fallow land sites are created to provide an extra food source, since all three Harrier species diets consist for a large part of vole. Additionally, field edges are sown with a variation of grasses and herbs, also with the aim to let vole flourish in the area. The Province Friesland chooses not to invest in creating feeding habitat for Montagu's Harriers (Province Groningen, 2013; Vlaanderen, 2013; Koole & Postma, 2010; Postma, 2011).

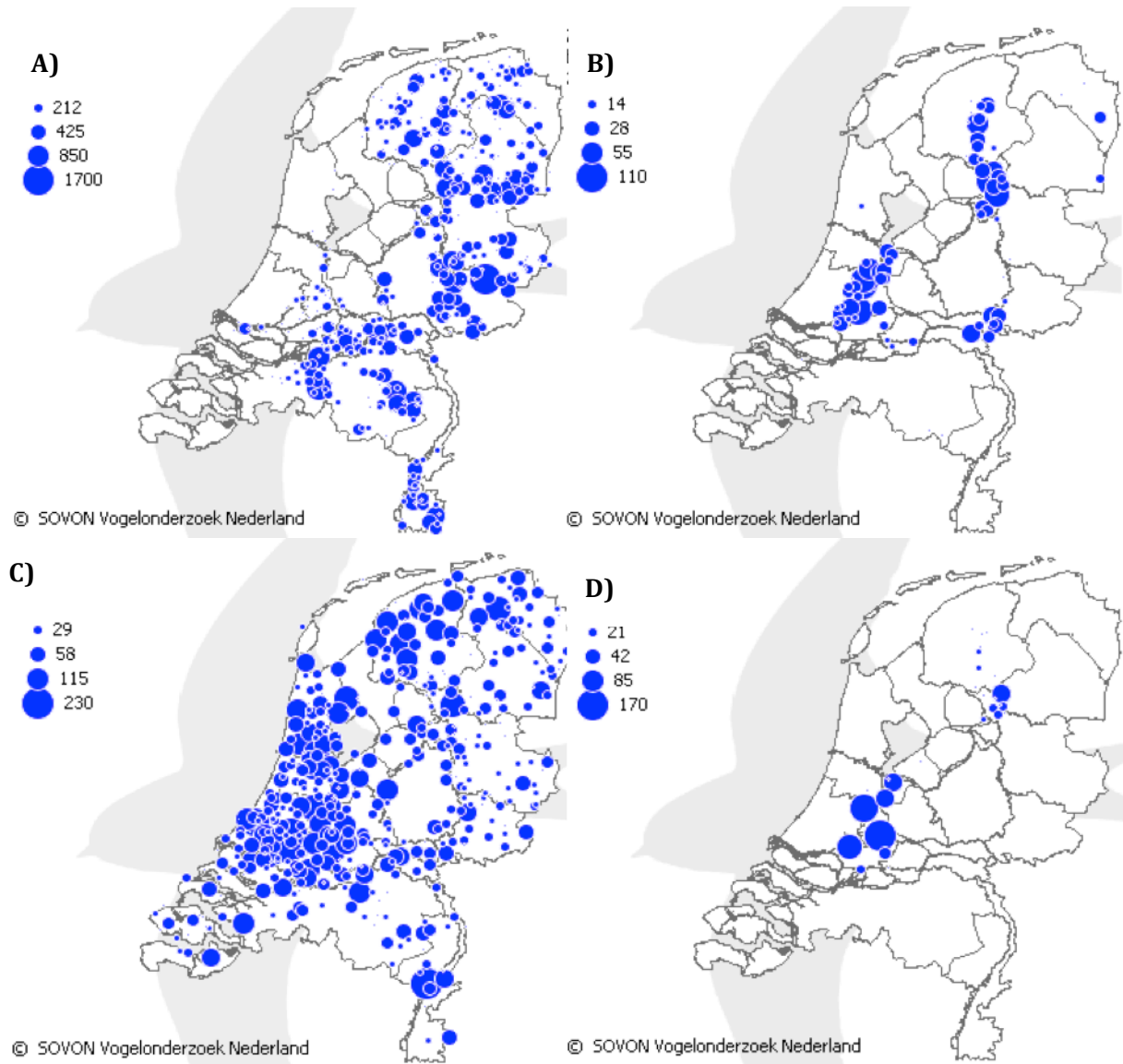
Hen Harriers especially breed on the Wadden islands, but numbers are declining. The Vogelbescherming advises to put effort in improving the food availability of the Harriers. This can be accomplished by lower grazing intensities in the dunes, creation of fallow land sites and winter standing crops on the Wadden Islands (Vogelbescherming Nederland, 2013).

### ***Distribution of avian predator species***

Predator and prey species often live close to one another. Avian prey species have adapted to the near presence of predators by carrying out anti-predator behaviours as seen in flock forming, foraging and vigilance. Two interesting aspects involved in the onset of these distributions are intra-guild predation and nesting associations. Intra-guild predation means that one raptor species eats another (Quinn *et al.*, 2008). This is for example the case for Northern Goshawks, which occasionally prey on Common Buzzard chicks and adults. Apart from actively avoid nesting close to Northern Goshawks, Buzzard breeding success is negatively affected by Goshawk presence (Kruger, 2004). With this given, nesting close a Goshawk nest might be beneficial for species preyed by Buzzards. The near presence of Goshawk nests than functions as a 'protective umbrella' against Buzzard predation, this is observed for small singing bird species (Quinn & Ueta, 2008). Other influences on distributions can be, as repeatedly mentioned, openness (vegetation cover, buildings etcetera) and food availability.

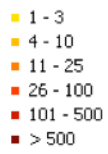
Based on occurrence and habitat requirements I made a selection of avian predators that might be influenced by the removal of trees, brushwood, bushes and reed-land. Species that breed throughout the Netherlands are Common Buzzard, Common Kestrel, Sparrowhawk, Hobby, Northern Goshawk, Common Magpie, Jackdaw, Carrion Crow (Appendix 1). Grey Heron breeds more frequently in the Western half of the Netherlands (figure 6c). Breeding birds that only occurring in parts of the Netherlands are Hen Harrier (Wadden islands), Marsh Harrier (West-Netherlands), Montagu's Harrier (Flevoland and North-Groningen), Peregrine Falcon, Raven (Utrecht/West-Gelderland), White Stork (figure 7). Rook breeds in the East of the Netherlands and Black Tern and Purple Heron breed in only small parts of the Netherlands (figure 6). Management activities are not directed to yard plants and

cultural characteristic vegetation (e.g. pollard Willows along dikes). Also most forests are included in the protected habitat type 'forests' incorporated in the Natura 2000 habitat directory. Therefore I assume that true forest-bound avian predators such as Sparrowhawk will encounter no negative effects from the restoration of openness in meadow bird core areas.



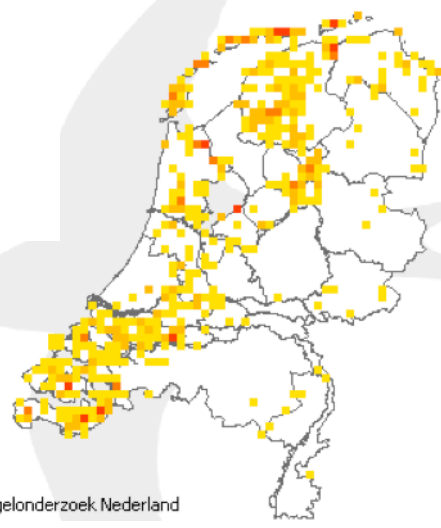
**Figure 6.** Breeding distribution and densities of **A) Rook B) Black Tern C) Grey Heron and D) Purple Heron** from 2005-2008 (SOVON Vogelonderzoek Nederland, 2013)

**A)**



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**B)**



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**C)**



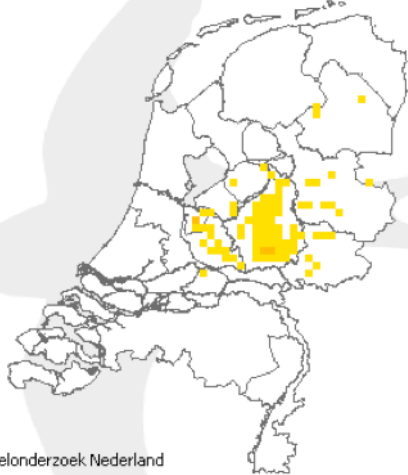
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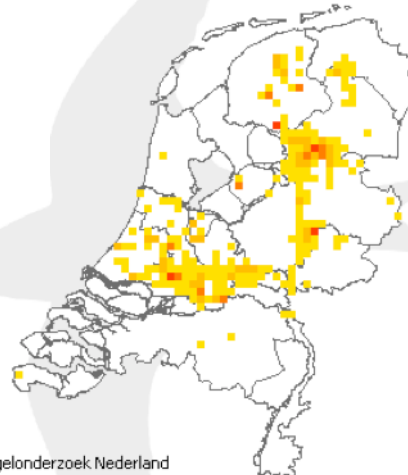
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**E)**



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**F)**



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**Figure 7.** The distribution of breeding pairs of **A)** Hen Harrier (2005-2008) **B)** Marsh Harrier (2005-2008) **C)** Montagu's Harrier (1998-2000) **D)** Peregrine Falcon (1998-2000) **E)** Raven and (2005-2008) **F)** White Stork (2005-2008) (SOVON Vogelonderzoek Nederland, 2013)

## **Discussion**

In this review I addressed the following question: What are the necessities and the effects of removing tall vegetation (reed and woody plants) from Dutch meadow bird areas on waders and avian predators?

### ***Openness & meadow bird occurrence***

Meadow bird occurrence is related to the openness (minimal sight distance) of an area. Buildings, up-going vegetation (reed, trees, thickets) and other vertical elements (e.g. electricity pylons and poles) disturb openness. Predators have higher predation success rates at areas nearby these up-going elements, covering their approach to prey (Bijlsma 1990 in Duijns *et al.*, 2009). This suggests that predation risk for meadow birds declines with the distance from cover. The spatial scale of structural landscape influences varies with a species' territory size and distances of foraging trips during the breeding season (Soderstrom & Part, 2000).

The prevailing idea for meadow bird conservation is optimizing meadow bird management effort in core areas harbouring high densities of Godwits (>15 pairs/100 ha) and other meadow birds. This would have better effects than spreading conservation efforts. Well functioning stable meadow bird core area reserves must have a minimal extent of 50 ha, with optimal meadow bird management. These areas should, according to van 't Veer *et al.* (2008) be surrounded by a minimal 250 m contour buffer of open grassland area free from disturbances of roads, trees and buildings. Stable meadow bird areas are therefore minimal 132-164 ha (van 't Veer *et al.*, 2008). The buffer grassland area is agriculturally managed. The province Noord-Holland is working on the designation of core areas. In the future management of the Netherlands' whole meadow bird area will be following this core area concept.

### ***Is predation of meadow birds a problem?***

The Netherlands harbours a large proportion of the total European population of meadow wader species. These waders form the bird species group that declined most in Europe since 1990. Although Lapwing and Godwit shifted from a decrease to an increase and Oystercatcher declined less steeply the revival is not seen as a turnaround, since previous revivals were followed by renewed declines (Teunissen & Calijn, 2013).

Wader predation seems to depend on the density of nests. The decline of wader population numbers in combination with an increase in predator numbers therefore has a reinforcing effect on predation. Also, starvation in winter causes meadow birds (by all means Redshanks) to take increased risks while foraging. This results in larger predation losses.

In order to reach stable populations nest losses above 50% are mentioned by MacDonald & Bolton (2008) to be unsustainable for sufficient chick survival (>25%). In 57.7% of the reports predation exceeds this number (MacDonald & Bolton, 2008).

Both mammals and birds are identified as predator. Mammal predators are Red Fox (*Vulpes vulpes*), several mustelidae species (Weasel, Marten, Polecat, Ermine), Hedgehog, Cat and Dog. Birds observed preying eggs, chick or adult waders are Marsh Harrier, Hen Harrier, Common Buzzard, Kestrel, Peregrine Falcon, Northern Goshawk, Sparrowhawk, Raven, Carrion Crow, Jackdaw, Rook, Common Magpie, Black-headed Gull, Common Gull, Herring Gull, Lesser Black-backed Gull, Grey Heron, White Stork, Oystercatcher and Jay. In the Netherlands, the most common egg predators are Red Fox (57%), Stoat (20%) and Carrion Crow (3%). So, birds have a relatively small share in egg predation. According to the study of Teunissen *et al.* (2005) most important chick predators are Grey Heron (8-18%), Common Buzzard (12%) and Carrion Crow (6%). The other species only incidentally preyed meadow birds. During the study of Teunissen *et al.* (2005) of the 'disappeared' Lapwing and Godwit chicks of 40% had an

unknown fate (of which 32% went missing), 47% was eaten, 5% died by agricultural activities, 5% was drowned and 3% had another cause of death (trampled by cattle, starvation, aggression, or hypothermia) (Teunissen, *et al.*, 2005). Since tags are not able to withstand the digestive system of mammals such as Foxes and Cats these mammals possibly account for many of the missing chicks (Jonge Poerink, 2009). This indicates that avian predators have a relatively small share in reproduction losses of meadow birds. Starvation was shown to account for 4% of the dead chicks. Probably, the impact of predation is overestimated because of scavenging or predation on starved chicks.

The survival of Godwit chicks was related to the parcel type location of the nest. Predation chance was higher on recently mown or grazed grassland (<18 cm.) and in regrown grassland. No relation was found between agricultural management and Lapwing predation.

In short, predation is in combination with other causes of population losses a pressuring factor on Lapwing and Godwit reproductive success. However, optimal mowing regimes and increased food availability for chicks might lower predation levels.

### ***Openness & predation control***

Only little research is performed on outcomes of predator management and the safeguarding of openness. In a study of White *et al.* (2008) openness was increased and small mammals and Corvid predator species (Magpie & Carrion Crow) were managed simultaneously. Habitat variables and predator abundances interacted. The surrounding habitat appeared to be important during the egg stage and the location of the nest was important during the chick stage. Management effects were positive, however, other explanations could not be eliminated because of a non-experimental set-up (White *et al.*, 2008).

Predation management is only allowed on Foxes, Rooks and Carrion Crows in areas where they provide nuisance. Further hunting on native bird species, or removing or disturbing birds of prey nests during the breeding season is prohibited according to the Flora- & Fauna Act. Within the boundaries of the law (with some exemptions) it is assigned to the provinces to reduce predation pressure on meadow bird populations to an acceptable level. This is done in an area-based approach in order to maximally stimulate and facilitate operators.

The meadow bird area nearby Idzegea (province Friesland) already brought core area conservation into practice and its predation management plan is seen as an example. Friesland incorporated this in meadow bird landscapes policy by removing tall landscape elements, reed, brushwood (originating bushes, trees and reeds) and potential nesting trees for the Common Buzzard, Northern Goshawk, Sparrowhawk, White Stork, Grey Heron and Kestrel from meadow bird breeding area.

Also the other Provinces remove up-going landscape elements in order to enhance openness. Not every province uses active predator management. The measures enhancing openness are restricted by cultural historical values, designations as Natura 2000 areas, Flora- and fauna act, Forest Act and the APV log regulation. When compatible with these regulations trees are permanently logged, thickets are cut short every three to four years and reed cover is mown every 1-3 years (depending on the area). The removal of reed can also have reverse (negative) impact on meadow bird predation, since reed also provides habitat for alternative prey (Coots, ducks etcetera). Since a complete oversight on the scale of tall vegetation removal is missing it is difficult to estimate the effects on raptor populations. Also, effects of increasing openness in meadow bird area on all avian predator populations are not specifically monitored and they are not compensated by additional habitat elsewhere.



### ***Value of tall vegetation***

Tall landscape elements (as in the green-blue network: in Dutch 'groenblauwe dooradering') have several ecological functions and many species depend on them. These species do not only include the mentioned avian and mammalian predator species, but e.g. also many insects, birds, amphibians, plants and bats. Examples of ecological functions are plague-control and pollination. It also has esthetical value by contributing to spatial diversity and cultural-historical value (van Doorn *et al.*, 2012; Geertsema, 2002).

Most important, these tall elements, such as brushwood, reeds, fallow field margins, trees and hedgerows contribute to the greenblue network. Habitat fragmentation is one of the main threats to species all over the world. It is therefore important to identify if increasing the openness of meadow bird areas may result in fragmentation of the habitat of species inhabiting tall vegetation. If tall vegetation loses too many greenblue network connections it might be possible that some of these species' populations collapse. The fragmentation threshold for population collapse will depend on several species characteristics, such as the degree of habitat specialism and the ability of species to reach other suitable habitat patches (Fahrig, 2003).

### ***Predator Habitat***

The removal of tall vegetation will probably have no negative effect on Gulls, since they usually breed along coasts, in dunes or on buildings. Gulls also need no tall vegetation for foraging. Since meadow bird management is also directed to increasing food availability in grasslands (invertebrate and insect densities), this will more likely have positive than negative effect on Gull population sizes.

All three Harrier species nest on the ground, Marsh Harriers between reed and shrubs in marsh area. Hen Harrier breeds between inaccessible low vegetation or between shrubs and Montagu's Harrier in developing brushwood in grain fields or long fallow fields. All three Harrier species mainly eat vole and therefore need fallow areas with a variety of herbs and grasses.

Black Terns breed on floating vegetation and are for food and habitat not dependent on meadow areas.

White Storks breed on human buildings, high voltage pylons, tall independent trees and in artificial nests on poles. In 1969 White Storks were after being extinct in the Netherlands, successfully reintroduced (Vogelbescherming Nederland, 2011). They are not dependent on the vegetation directly around meadow bird core areas since they also breed in tall trees, artificial nests and electricity pylons (nearby meadows) in proximity of humans. Additionally, it is not allowed to remove or disturb already existing nests. So, White Storks have enough other breeding opportunities.

Other tree breeding birds are Common Buzzard, Kestrel, Hobby, Northern Goshawk, Sparrowhawk, Raven, Carrion Crow, Jackdaw, Rook, Common Magpie, Grey Heron and Purple Heron. Sparrowhawk has a preference for nesting in coniferous forests and hunts especially in forests. The restoration of openness in meadow bird core areas does not include clearing coniferous forest and will therefore have no effect on Sparrowhawk populations. Also Goshawk and Raven nest in forests. Although the Northern Goshawk usually nests in trees, the species is also observed to nest in open area. Hobby, Peregrine Falcon and Kestrel nest in Carrion Crow nests and need a habitat with both open area and tall vegetation. Since two of these species have the Red List status vulnerable, removing this vegetation in important breeding or wintering areas might have negative impact on population numbers. Ravens live in forests, heath land and raised bogs and the Rooks habitat consists of river area, agricultural fields, forest and grassland. Rook, Buzzard and Grey Heron are sensitive to human disturbances.

### ***Predator occurrence & distribution***

Management measures are only locally. Therefore I assume that species generally breeding and occurring throughout the country have enough alternative habitats to relocate to. Increased openness in meadow bird areas will therefore probably have no significant influence on population numbers of Common Buzzard, Common Kestrel, Sparrowhawk, Hobby, Northern Goshawk, Common Magpie, Jackdaw, Carrion Crow. For species occurring less general throughout the country overlap in habitat will be important determining effects of vegetation removal. These species are Hen Harrier (Wadden islands), Marsh Harrier (West-Netherlands), Montagu's Harrier (Flevoland and North-Groningen), Peregrine Falcon, Raven (Utrecht/West-Gelderland), White Stork (figure 6), Rook (East) and Black Tern and Purple Heron who only breed small parts of the Netherlands (figure 5). These species and Hobby are incorporated in the Dutch Red List with the exception of Marsh Harrier and White Stork. However, Marsh Harriers are protected according the Natura 2000 Act.

### ***Habitat Overlap***

All mentioned predators have certain overlap in habitat with meadow bird. Here, I focus on distribution in order to assess the magnitude of the geographical overlap and therefore the magnitude of effects from increasing the openness of meadow bird area. Wader areas are mostly present in the Western half of the Netherland and Rook and Common Goshawk breeding areas especially in the Eastern half. On the map wader areas overlap with Marsh Harrier, Raven, White Stork, Black Tern, Grey Heron and Purple Heron breeding areas. Small overlap in habitat is with Hen Harrier and Montagu's Harrier.

### **Conclusion**

Optimal management in core areas is necessary in order to successfully maintain wader species. Since the exact impacts of increasing openness on many species are unknown it is best to tackle other meadow bird pressures first. According to the provinces, measures are taken at local scale specifically addressing the species (also avian predators) that occur in that area. This is positive for the more rare avian predator species. Also, management concerning openness is, according to the provinces, done on a relatively small scale (only in meadow bird core areas and surrounding grassland areas). Bird nests that are repeatedly used are except for existing Carrion Crow nests, not removed. Therefore avian predator species with a broad habitat are probably able to relocate to surrounding areas.

The removal of reed can have reversed (negative) impact on meadow bird predation, since reed also provides habitat for alternative prey (Coots, ducks e.g.). It is therefore important not to mow all reeds in the (meadow bird) area.

Individuals that use the same nest repeatedly might (unless exemption on regulations is granted, or the environment is altered in a way that makes it unsuitable for further nesting) continue breeding in the area. Hen Harrier, Montagu's Harrier, Marsh Harrier, Raven, Grey Heron and Purple Heron occur in areas that overlap with meadow bird areas.

Peregrine Falcon is a sporadic breeder in the Netherlands with scattered locations. It is important assessing if other species than Carrion Crow nest in Carrion Crow nests. The removal of Carrion Crows nests might have negative effects on Peregrine Falcons and Hobby (which have both a vulnerable protection status). It is important to assess if these species breed in the area and when this is the case not to remove all Carrion Crows nests.

Close monitoring of population dynamics of both meadow bird populations and avian predator species is needed in order to detect possible threats. This is especially important for more rare species such as the three Harriers and Purple Heron. Thereby it

is important for these species (also for Grey Heron) to create vole rich places as an alternative food source. This might have positive effects on avian predator populations, but will when located strategically outside the meadow bird area most likely lower predation pressure in the area. Management measures are regulated on the local scale and national maps and data are not yet available. A complete detailed oversight will enable an assessment of overall risks for predator species. Also, more insight is needed in the effect of increasing openness of meadow bird areas on the green network of tall vegetation in the Netherlands. This is needed in order to prevent fragmentation and isolation of tall vegetation areas, which might result in species population collapses (not only avian predators). In short, the opening of meadow bird areas is probably inevitable but should be compensated with the establishment of green network and predator species need to be monitored.

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## **Appendix 1: Questionnaires**

### ***Province Utrecht***

In provincie Utrecht is geen gericht of structureel beleid op handhaven of verminderen van de roofvogelpopulatie ten behoeve van de weidevogels.

In de weidevogelgebieden van provincie Utrecht is tot op heden namelijk geen probleem gesignaleerd met predatore roofvogels, vormen roofvogels een gering risico voor weidevogels en is sterfte en predatie van roofvogels op weidevogelnesten of – kuikens geen beperkende factor.

Handhaven van de openheid van (weidevogel)gebieden en predatiebeheer (van roofvogels) zijn in provincie Utrecht niet op elkaar afgestemd, maar gescheiden in verschillende instrumenten.

Weidevogelbeheer in provincie Utrecht is in het agrarisch gebied geregeld via via de Subsidie Natuur en Landschap (SNL). In 7 weidevogelgebieden stellen 6 gebiedscoördinatoren (GC, 1 coördinator doet 2 plannen) een beheerplan op, waarbinnen individuele agrariers binnen het SNL beheersovereenkomsten afsluiten. Hierin staan wel wensen over landschappelijke kwaliteit en predatiebeheer, maar GC hebben geen middelen of instrumenten om deze te verwezenlijken.

Planologisch is de bescherming van deze weidevogelgebieden geregeld in de Provinciaal Ruimtelijke Structuurvisie (PRS) via het landschapsbeleid, namelijk op basis van de kernkwaliteit openheid van het landschap behouden.

Predatiebeheer (o.a. vogels en zoogdieren) in provincie Utrecht is geregeld binnen het faunabeheerplan Utrecht, waarvan de feitelijke uitvoering berust bij 13 WildBeheerEenheden (WBE). In het faunabeheerplan worden wel ganzen, watervogels en kraaiachtigen (ekster, roek, kraai) benoemd, maar geen predatore roofvogels (buiserd, kiekendief, havik, sperwer). Dit hangt samen met het doel economische schade of wettelijk belang.

In Utrecht is eigenlijk alleen het beleid en beheer rondom de Vos in relatie gebracht met weidevogelgebieden. In deze gebieden geldt een zogenaamde 0 stand. Op dit moment worden er geen bomen/ruigte/riet verwijderd omdat deze het leefgebied van roofvogels vormen of hun nestplaats in de weidevogelgebieden.

In natuurgebieden maken beheerders wel een keuze in hun beheermaatregelen gebaseerd op hun doelen. M.a.w. als het natuurdoel riet is, wordt het beheer hierop afgestemd, bijv. 1X per 1-3 jaar maaien in zomer of winter. Maar dit gebeurt niet vanuit predatiebeheer

Als het doel weidevogelgrasland is, worden maatregelen genomen om het gebied open te houden, bijv. bosopslag verwijderen, riet of ruigte terugdringen.

Formeel dient voor de verwijdering van jaarrond nestbomen een ontheffingsprocedure in het kader van de Flora- en faunawet te worden doorlopen. Hiervoor is het bevoegd gezag nu nog Dienst Regelingen (DR) van Ministerie ELI, in de toekomst wordt dit provincie.

### ***Province Limburg***

In ons provinciale Ruimtelijke Beleid proberen we de open weidevogelgebieden zo veel mogelijk te vrijwaren van verdichting. Door bijv. aanleg van bos en oprichten van gebouwen zo veel mogelijk te beperken.

o verwijderen potentiële nestbomen en uitzichtpunten roofvogels, kraaien: Ja struweel rond en in weidevogelgebied wordt om de vier jaar afgezet, om openheid te behouden en vestiging van predatoren als Zwarte Kraai, Ekster, Gaai en Buiserd te voorkomen. Binnen het weidevogelreservaat van SBB gaat het om alle struwelen. Deze struwelen bestaan onder andere uit boomsoorten als Amerikaanse Vogelkers, Ratelpopulier, Zomereik en Vuilboom. Dit wordt alleen gedaan in de reservaatgebieden



en niet in de beheergebieden (agrarisch weidevogelbeheer). Dit is heel weinig, ca. 0,02% van de provincie Limburg

o maaien rietzones en ruigtes wordt niet gedaan.

Alternatieve voedselbronnen voor predatoren worden niet aangeboden, want dat werkt averechts en bevordert de dichtheid aan predatoren. Voedselbronnen voor weidevogels? Het weidevogelbeheer voorziet hierin, hoge waterstand en bemesting met ruige stalmest.

### ***Provincie Overijssel***

Lokaal in goede weidevogelgebieden worden uitzichtpunten voor roofvogels en kraaien verwijderd om openheid te versterken; betreft uitzichtpunten; niet specifiek gericht op bepaalde roofvogelsoorten.

Het maaien van rietzones en ruigtes wordt lokaal gedaan in goede weidevogelgebieden om openheid te versterken. Dit is op zeer beperkte schaal (dit beslaat veel minder van 1% van de Provincie). Er wordt niet gecompenseerd voor het verwijderen van potentiële nestbomen van predatoren.

Het provinciaal beleid biedt de mogelijkheid voor WBE's om lichtbakvergunningen voor het bejagen van de vos aan te vragen in een straal van 5 km in en om de in het Natuurbeheerplan begrensde nieuwe natuur en het collectief weidevogelbeheer (agrarisch natuurbeheer).

### ***Weidevogelgebied Ronde Hoep***

De Ronde Hoep doet het volgende aan het bewaren van de openheid van het weidevogelgebied: verwijderen potentiële nestbomen en uitzichtpunten voor met name buizerd, havik en zwarte kraai, maaien rietzones en ruigtes, opruimen takkenbossen en houtstapels, alternatieve voedselbronnen aanleggen tijdens de broedtijd. Het gaat vooral om geriefhoutbosjes die vroeger bomen van tientallen jaren oud bevatte en nu iedere 3 of 4 jaar kort worden gezet. Individuele bomen worden definitief verwijderd. Rietkragen worden in de winter gemaaid. Het deel van het weidevogelgebied dat bestaat uit bosjes en riet is ongeveer 1%.

Er worden jaarlijks inventarisatie kaarten gemaakt/ook voor en na het verwijderen van bomen. Uitkomsten zijn zeer positief: weidelanden rondom bosjes werden niet of nauwelijks door weidevogels gebruikt, na verwijderen van de bomen worden ze goed gebruikt.