UNIVERSITY OF COPENHAGEN
FACULTY OF SCIENCE

CENTRE FOR MACROECOLOGY,
EVOLUTION AND CLIMATE

PhD Thesis

Erik Buchwald

Analysis and prioritization of future efforts for Danish biodiversity

– with particular regard to Nature Agency lands

Academic advisors:
Associate Professor Jacob Heilmann-Clausen
Professor Carsten Rahbek

Submitted: February 2018

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Department:	Natural History Museum of Denmark, University of Copenhagen, Centre for Macroecology, Evolution & Climate (CMEC)
Author:	Erik Buchwald
Title:	Analysis and prioritization of future efforts for Danish biodiversity – with particular regard to Nature Agency lands
Topic description:	Industrial PhD-project undertaken from March 2015 to February 2018 with the aim to study and analyze where and how Denmark can make an efficient effort to stop the decline in biodiversity – particularly on the c. 2000 km^2 of Denmark managed by the Danish Nature Agency.
Academic advisors:	Associate Professor Jacob Heilmann-Clausen Professor Carsten Rahbek
Agency advisors:	Head of Division Mads Jensen Regional Forest Director Jens Bjerregaard Christensen
Submitted on:	28. February 2018
Front cover:	Designed by Lotte Nymark Busch Jensen & Erik Buchwald. Photos ©: Black woodpecker *Dryocopus martius* (Lassi Rautiainen), silver-washed fritillary *Argynnis paphia* (Erik Buchwald), the fungus *Pycnoporellus fulgens* (Jacob Heilmann-Clausen) and lying dead beech-tree (Erik Buchwald).

Preface

This thesis is the culmination of a three-year Industrial PhD project conducted in co-operation between the Danish Nature Agency (Ministry of Environment and Food of Denmark) and the Centre for Macroecology, Evolution and Climate (CMEC, Natural History Museum of Denmark, University of Copenhagen). The project has been supervised by Associate Professor Jacob Heilmann-Clausen and Professor Carsten Rahbek. From the Danish Nature Agency, Head of Division Mads Jensen and Regional Forest Director Jens Bjerregaard Christensen have acted as agency advisors.

The thesis consists of three parts. First a synopsis with background and overview of the work. The second part consists of 4 chapters with the primary written products of the PhD project - two manuscripts for peer-review and two published reports for the agency and Danish stakeholders. These chapters form the core part of the PhD thesis. Finally, the third part consists of three appendices with other articles published or in peer-review during the project period, but not part of the original Industrial PhD plan.

In addition to the research output presented in this thesis, up to half of my time in the project period has in line with the Industrial PhD obligations been used for consultations, meetings, excursions, workshops and other dissemination of preliminary and final results of the work to the Danish Nature Agency in order to make quickest possible use of the results, so they could benefit management and conservation actions already during the project period.

At the same time I have also been heavily involved with fieldwork for the third Danish Atlas of Breeding Birds, been member of the board of the national Danish Botanical Society, and undertaken quality assurance of a number of taxon groups for the citizen science project www.fugleognatur.dk.

Erik Buchwald

Copenhagen, 28th February, 2018

Contents

Summary

It has been widely documented that biodiversity both globally and in Denmark is in decline and that many species are threatened with extinction. Analyses in 2011-2013 of the status of Danish biodiversity and of the recent efforts to help it pointed out the need for a more focused approach to management and conservation, targeted more at threatened species, and recognizing that forests are of major importance for a very large proportion of the threatened species. A large part of the analyses were based on 10 x 10 km grid cell data for Denmark and thus difficult to apply in practical management.

The aim of this Industrial-PhD-project was to investigate and analyze, where and how a more specific and effective effort can be done to achieve the political 2020-targets about halting the decline in biodiversity – especially on the c. 5% of Denmark managed by the Nature Agency. First of all I delimited the more than one thousand species of animals, plants and fungi that influence whether Denmark can reach the EU and UN biodiversity targets for 2020 (chapter 3). I then compiled and quality checked data on the occurrences of these species 1991-2015 and analyzed to which extent each species occurred in Special Areas of Conservation (SACs) or in other types of nature protected areas (chapter 1).

Using the optimization program *Marxan with zones* I studied how species could be protected better in a cost-effective way, and related the results to the government´s "Nature-package" decision from May 2016. It determined that 10,000 ha of new untouched forests and 3,300 ha of new forests protected as "other biodiversity forests" shall be designated on Danish Nature Agency lands (chapter 2 and 4). Results and data were supplied to the Nature Agency as soon as available in the project. The analyses in chapter 4 thereby became a significant part of the basis for the proposal including more than 13,300 ha of new protected biodiversity forests, which the Nature Agency publicly announced on February 2nd 2018 as implementation of the "Nature-package" decision.

Unrelated to the original PhD plan, I was invited to contribute to a study "Where are Europe´s last primary forests". To my joy the authors had chosen definitions and terminology published by me in 2005 as the most appropriate for the study (Appendix I). Similarly I co-authored an article on the development in number of breeding bird species in Denmark since 1800 (Appendix II) and was invited to write a piece on my PhD project to a thematic journal issue on Biodiversity and Forest (Appendix III).

Dansk resumé

Det er veldokumenteret, at biodiversiteten både globalt og i Danmark er i tilbagegang, og at mange arter er truet af udryddelse. Analyser i 2011-2013 af den hidtidige status og indsats for dansk biodiversitet pegede bl.a. på behov for en tilgang til forvaltning og beskyttelse, som er mere målrettet truede arter, men også på at skovene er af afgørende betydning for en meget stor andel af de truede arter. Analyserne var i høj grad baseret på data for Danmark opdelt i 10 x 10 km kvadrater og derfor vanskelige at omsætte i praksis.

Dette Erhvervs-PhD projekts formål var at undersøge og analysere, hvor og hvordan man mere konkret kan gøre en effektiv indsats for at nå de politiske 2020-mål om at hindre tab af biodiversitet – særligt på de ca. 5 % af Danmark, som forvaltes af Naturstyrelsen. I første omgang identificerede jeg de over tusinde arter af dyr, planter og svampe, der er af betydning for, om Danmark kan nå de i FN og EU politisk vedtagne 2020-mål om biodiversitet (chapter 3). Jeg samlede og kvalitetssikrede derpå data om arternes forekomst 1991-2015 og analyserede i hvor høj grad hver art forekom i habitatområder eller i andre typer beskyttet natur (chapter 1).

Ved hjælp af optimeringsprogrammet *Marxan with zones* undersøgte jeg, hvordan arterne på omkostningseffektiv vis kunne beskyttes bedre, og satte det i relation til regeringens Naturpakke fra maj 2016, som fastlagde, at der på Naturstyrelsens arealer skal beskyttes ekstra 10.000 ha urørt skov og 3.300 ha ekstra anden biodiversitetsskov (chapter 2 og 4).

Delresultater og data blev løbende stillet til rådighed for Naturstyrelsen. Analyserne i chapter 4 blev dermed en væsentlig del af grundlaget for de forslag til mere end 13.300 ha ny beskyttede biodiversitetsskove, som Naturstyrelsen sendte i offentlig høring den 2. februar 2018 som udmøntning af Naturpakken.

Udenfor den oprindelige PhD plan blev jeg i forløbet inviteret til at bidrage til et europæisk studie om længe urørte naturskove, som til min glæde baserede sig på definitioner og terminologi, som jeg havde publiceret i 2005 (Appendix I). Tilsvarende medvirkede jeg til en opdateret artikel om udviklingen i antallet af danske ynglefugle siden 1800 (Appendix II), og jeg blev inviteret til at skrive om PhD projektet i et temanummer om biodiversitet og skov (Appendix III).

Acknowledgements

This study has only been possible due to support and help from a large number of people, who I am greatly indebted and grateful to. First of all I want to thank my main supervisor **Jacob Heilmann-Clausen**, who has helped me in all sorts of ways, has improved the quality of my work, and allowed me to share office and ups and downs for the past years. Thanks also to co-advisors **Carsten Rahbek**, **Mads Jensen** and **Jens Bjerregaard Christensen** for support, good discussions and for believing in me and my work.

Right since my first ideas in 2014 fostering the project I am hugely grateful for non-ending support from my superiors **Mads Jensen** and **Peter Ilsøe** at the Danish Nature Agency who allowed me to apply for the Industrial PhD grant in order to improve the scientific basis for nature conservation in the agency. **The Danish Nature Agency** and **Innovation Fund Denmark** (industrial Ph.D. grant no. 4135-00145B) are sincerely thanked for granting the economic support. Also in the implementation period all colleagues and superiors in the agency deserve my sincere thanks for total commitment to support me in all ways necessary to make the project a success for me. It has been a particular delight to discuss issues and receive help from my close colleagues **Erling Krabbe, Rune Hauskov Kristiansen, Karsten Wandall, Mogens Krog, Per Lynge Jensen, Erik Kristensen** and **Bjørn Ole Ejlersen**, besides enjoying a beer, snack and laugh with them when occasion gave the possibility. **Peter Ilsøe, Signe Nepper Larsen, Mads Jensen** and **Jens Bjerregaard Christensen** finally deserve great respect and thanks for whole-hearted leadership supporting the use of results from scientific conservation planning.

No less gratitude goes to my major workplace for the last three years - Professor **Carsten Rahbeks** wonderful CMEC, **Centre for Macroecology, Evolution and Climate**. Carsten has succeeded in building a unique and inspiring center with some of the world´s leading researchers in these fields, which I am grateful to have been a part of. Thanks, Carsten, for giving me the chance to try to learn from you, and to translate science into recommendations for applied conservation actions.

At CMEC I have received invaluable help and support from many colleagues who are all thanked, but special thanks must go to **Anders H. Petersen** (Worldmap software, spatial conservation planning and numerous fruitful discussions), **Bjørn Hermansen** (GIS and IT wizard), **Louis A. Hansen** (Worldmap software), **Lotte Nymark Busch Jensen**

(Indesign and layout), **Lykke Pedersen** (PhD practicalities and timing) and **Jonathan Kennedy** (R programming help). Erik Buchwald acknowledges the **Danish National Research Foundation** for funding for the Center for Macroecology, Evolution and Climate (grant-number DNRF96). For help with statistical problems I thank **Bo Marcussen** at the Laboratory for Applied Statistics, University of Copenhagen for helpful discussions and ideas at short notice.

This study would not have been possible without the immense data collection efforts of numerous persons active in **Birdlife Denmark, Lepidopterological Society, Danish Mycological Society, Danish Botanical Society, Entomological Society of Fünen, Spiders of Denmark** (online database), the **Natural History Museum of Denmark**, the **Danish Nature Agency** and Birds & Nature web-database (**Fugle & Natur** license B05/2014). All persons and organizations involved deserve sincere thanks for their efforts and for permitting use of data.

For help with extracting data from major data collections I would like to specifically thank **Thomas Vikstrøm** and **Timme Nygaard** at Birdlife Denmark and **Jesper Fredshavn, Jesper Bladt, Jesper Moeslund** and **Rasmus Ejrnæs** at DCE (Danish Centre For Environment And Energy). Species experts **Jan Pedersen** (Coleoptera), **Nikolaj Scharff** (Arachnida) and **Ulrik Søchting** (Lichens) at the Natural History Museum of Denmark are thanked for help and expert consultations. **Isabel Calabuig,** your great help when uploading my data to GBIF is much appreciated. Thanks also to **P.H. Williams** for kindly providing the WORLDMAP software and to **H. Possingham** and **M. Watts** for providing the Marxan with zones software.

Last but not least my deep-felt thanks and devotion go to my family. **Hanne** you are a constant help, inspiration and wonderful companion and support. It is a great joy for me when we together set out to explore the many fascinating nature sites and species of Denmark (and Sweden and India etc.). You brighten up all my days with your smile. **Morten**, thanks for nice father-and-son talks over lunch here at Campus, while we both were working on our PhD-studies on either side of the Campus lawn. You proudly earned your PhD-title in December 2017 just a few months before my deadline. **Lasse**, you have also made me proud by great results in your education and career, and by overcoming the obstacles which come in your way - even when they seem impossible. Finally I am so grateful to my parents **Vagn** & **Kirsti** for their love and support in so many ways, and for all the many wonderful dinners you have invited to, **Kirsti**.

SYNOPSIS

Analysis and prioritization of future efforts for Danish biodiversity

– with particular regard to Nature Agency lands

Erik Buchwald

Previous page: The author at fieldwork (Photo by Hanne Schüssler).

Synopsis

Introduction

It has been addressed widely in the literature that decline of global biodiversity including extinction of threatened species is a pressing issue (e.g. Dirzo et al. 2014; Newbold et al. 2015; Pimm et al. 2014; Steffen et al. 2015). This has lead to political agreements of which the United Nations (UN) Convention on Biological Diversity (CBD) 1992 and its follow-up decisions are of major importance (Venter et al. 2014, 2017; Watson et al. 2016). The COP 10 meeting (UN-CBD conference of the parties) at Nagoya 2010 adopted 20 so-called Aichi targets among which target 12 is especially important for the present PhD project: "By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained" (CBD 2010).

It has been shown that biodiversity represents a very large value for society which can be measured by the billions of Danish kroner (Petersen et al. 2012). Loss of species similarly represents an economic loss for society. Therefore prevention of loss is highly relevant both for economic benefits, but not least because of the ethical and moral aspects of nature protection, and giving opportunities for people to enjoy a rich and diverse nature.

For Denmark and the European Union (EU) implementation of the 'Habitats Directive' (EU 1992) is one major effort to deliver on the CBD and Aichi targets together with the 'Birds Directive' (EU 1979). The EU has specified six biodiversity targets for 2020 which to a high degree relate to implementation of those two directives (EU 2011). A major part of the efforts from the Habitats Directive targets management and conservation of Special Areas of Conservation (SACs) as part of the Natura 2000 network (Evans 2012; Maiorano et al. 2015). The SACs were selected as sites with occurrence of species listed on Annex II of the directive or on the basis of presence of threatened or characteristic habitats listed on Annex I (Battisti & Fanelli 2015; van der Sluis et al. 2016).

But it was an open question how well SACs and other protected areas of Denmark cover the threatened species relevant for Aichi target 12, and similarly it was not known if the ecological requirements and preferences of the threatened species matched the conservation regime at their occurrence sites. In short there was no certainty that the protection regime would deliver. In the light of recommendations from previous studies (Ejrnæs et al. 2011; Johanssen et al. 2013; Petersen et al. 2012), it was decided in this PhD project to focus on terrestrial and amphibious species, on forests and on the lands of the Danish Nature Agency, and study the possibilities for improved evidence-based conservation.

Thesis outline - research problem

Solving the problem of selecting the most appropriate and cost-effective network of sites for protection and conservation of threatened animals, plants, fungi, and other segments of biodiversity is an issue for Systematic Conservation Planning (Margules & Pressey 2000; Moilanen et al. 2009;Venter et al. 2014, 2017; Watson et al. 2016). It requires a lot of data and understanding of the distributions, ecology, and sites of the threatened species. How many and how large sites are necessary? Which type of management and protection is necessary? Are a few large sites better than many small sites?

The first studies on systematic conservation planning in Denmark are from around the turn of the century and were undertaken at a coarse geographical scale and with relatively few species included (Lund 2002; Lund & Rahbek 2002). A recent similar study regarding Danish forests recommended 75.000 ha protected as untouched forest (Petersen et al. 2016). An important aspect in this context is that these and many other planning studies only discern between "protected" and "unprotected" in the planning algorithms, which in many cases is too simplistic and may overestimate the economic costs of conservation (Watts et al. 2009; Wilson et al. 2010). Wilson et al. (2010) found that accounting only for the contribution of protected areas could overestimate the required expenditure by 15 times, and the area requiring strict protection by almost 50 times.

The previous studies in Denmark were only able to analyze species occurrences at a coarse scale of 10 x 10 kilometers and the latest study (Petersen et al. 2016) did not include data on existing protection. Moreover these studies only included a relatively small proportion of the more than 1500 threatened species present in Denmark. For all these reasons the results of the previous studies were not applicable in practical nature management or conservation which was already realized and highlighted in the studies.

Objectives

The main aim of the PhD project was to take Danish systematic conservation planning to a more detailed level in order to make it possible for the Danish Nature Agency to implement evidence-based actions in a cost-effective and prioritized way to help halt the decline in biodiversity as stated in the political 2020-targets of UN, EU, and Denmark. Recommendations were to be based on systematic conservation planning at a sufficiently detailed geographical level to match management needs.

Chapter 1 - How well do conservation sites based on annex II species of the EU Habitats Directive cover other threatened species relevant for the 2020 biodiversity targets?

This manuscript in preparation for submission to Biological Conservation for peer-review investigated the performance of Habitats Directive Annex II species as indicators of threatened species in site selection, and evaluated the effectiveness of actual protected areas (PAs) using complementarity based algorithm-optimization and gap analysis. Even though the species groups showed different distribution patterns, the Annex II species performed significantly better than random in identifying areas important for other groups using complementarity, both for globally threatened species (Table 1), for species threatened at the EU level, and also for the long list of nationally threatened species.

Table 1. *Globally threatened species occurring in Denmark 1991-2015 (excluding fully aquatic species). Species marked * are also on annex II of the Habitats Directive.*

Species name (and taxon group)	Number of 10km grid cells with occurrence	% of presence records in SAC polygons
Podiceps auritus (bird)	2	80
Ampedus hjorti (beetle)	21	51
Dytiscus latissimus (beetle)*	8	43
Graphoderus bilineatus (beetle)*	6	86
Formicoxenus nitidulus (ant)	14	69
Phyllodesma ilicifolia (moth)	32	35
Dolomedes plantarius (spider)	6	95
Vertigo moulinsiana (snail)*	88	59
Hygrocybe citrinovirens (fungus)	19	43
Hygrocybe ingrata (fungus)	29	43
Tricholoma acerbum (fungus)	3	0

The Danish Special Areas of Conservation (SACs) which were selected based on a limited number (n=27) of EU Habitats Directive Annex II species had a much higher coverage (42 – 64%) of all known occurrences of 1344 threatened species than expected based on the SAC coverage of Denmark (8.6% of land area). This applied for both 137 internationally and 1207 nationally threatened species including less studied groups like fungi, mosses, and spiders. With generally three to eight times higher than 'baseline' coverage these figures are promising and underline that the designation of Danish SACs has been rather successful also for less well-known taxon groups and for species of global concern which were not direct targets. In total, 88% of all threatened species occurred in at least one SAC, and 42% of the 156 species missed by SAC polygons had occurrence instead in nationally protected areas of IUCN category I – IV (Dudley 2008).

Besides the indicator value of Annex II species there can be several reasons why the coverage of threatened species in the SAC network is so high. Importantly, Denmark is so heavily impacted by agriculture, urban areas, and infrastructure that SAC designation was more or less restricted to the c. 30% of the land with a more natural character. Hence, the random sets inevitably included an average of 70% land lacking natural habitats. However, the higher coverage of threatened species in the actual SAC set compared to the optimal set based on Annex II species suggests that the Danish designation process was of high quality targeting areas with high value for Danish nature in general, with low intrusion from economic interests.

Excluding Brexit UK, all other EU countries have designated more of their country than Denmark as Natura 2000 (including SACs). As the countries have had to follow the same principles of designation laid down in the Habitats Directive, a similar or higher coverage of threatened species is expected in those countries. Designation of PAs on the basis of multi-taxon species proxies is thus recommended as being efficient. This is in line with other studies, even though few have documented as high efficiency as here.

Chapter 2 - Marxan with Zones applied to prioritize management for threatened forest species in Denmark to improve reaching 2020 biodiversity targets

This manuscript in preparation for submission to PLOS ONE for peer-review has focus on selection of a cost-effective set of protected forests using a zoning approach. Refining "protection" to different categories or management "zones" relevant to the ecological requirements of different threatened species is highly relevant in systematic conservation planning, since some species require less than strict untouched protection (e.g. Bernes et al. 2015; Brunet et al. 2010; Lindenmayer & Franklin 2002; Lundström et al. 2016; Peterken 1996). Several available methods and software systems for Systematic Conservation Planning were screened including Zonation, C-Plan, Marxan, and integer programming methods (Moilanen et al. 2009). This resulted in the choice of Zonae Cogito (Segan et al. 2011) incorporating Marxan with Zones (Watts et al. 2009) as analysis platform, due to 1) their good documentation, 2) widespread use, 3) ability to work efficiently with several different types of protection / management at the same time (zones), 4) ability to simultaneously solve the planning problem for many hundred species distributed at many hundred different sites, and 5) incorporation with GIS to support an iterative interactive planning process (Segan et al. 2011; Watts et al. 2008; Wilson et al. 2010).

As an input to optimize cost-effective selection of new forest reserves we used presence data 1991-2015 for 626 forest species threatened at global, EU or national level. The species represented three biological kingdoms and presences were extracted from data sources comprising a total of 22 million species records. Species were grouped by ecological requirements and preferences based on data in the Danish official red list database and adjusted by expert consultation. Four Marxan zones were then defined to represent different protection regimes relevant for the different species groups and with various cost assumptions: 1) Normal, 2) Conifer woods with extra protection, 3) Active protection of semi-open deciduous woods, and 4) Untouched (minimum-intervention) deciduous woods. Targets were set to at least 3 or 5 representations in zones matching ecological preferences for each species.

26 scenarios were run in Marxan with zones to inspect sensitivity to input assumptions varying 1) cost as area or money, 2) cost of zone 2 and 3 compared to normal, 3)

exclusion of conifer affiliated species or of species not in decline, and finally 4) locking already fully protected forests a priori to the relevant zone 4. In addition, three control scenarios were run to test effects of including poorly known species and to evaluate the potential cost reductions achieved by working with protection zones. Success rate for scenarios was assessed as 1) cost (net income foregone) and 2) target achievement for 304 threatened species in decline and therefore top priority.

Results showed that, if carefully planned, the government decision of designating 13,300 ha of new protected forests (10,000 ha untouched and 3,300 ha other protection types) in the Danish State Forests should be able to provide most threatened species with relevant protection in all known sites for rare species (less than five occurrences in state forests), and in at least 5 sites for less rare species. Depending on cost assumptions, this implies a 38-46% loss of annual net income from wood harvest in the State Forests. Marxan with zones proved to be very effective and is highly recommended for solving this type of conservation problem.

It would have been optimal to analyze private and State forests together, and this has been done by Petersen et al. (2016) who analyzed priority forest areas countrywide for Denmark at 10 km grid cell scale. The present study used more detailed input data available for State Forests but not available for private forests.

Chapter 3 - Identification of species and habitats in the 2020 biodiversity targets.

This chapter was published as an industrial PhD-report in 2016. It analyzed the UN and EU biodiversity targets for 2020 in order to identify which species and habitats would influence the possibilities to reach the targets in Denmark with special focus on possibilities on Danish Nature Agency lands. The identified species delimited the study species used in other parts of the PhD-project.

At UN level Aichi target 12 was of primary importance for identification of focal species: "By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained" (CBD 2010). At EU level six biodiversity targets have been specified for 2020 of which target 1 was primarily important for identification of focal species: "To halt the deterioration in the status of all species and habitats covered by EU nature legislation and achieve a significant and measurable improvement in their status so that, by 2020, compared to current assessments: (i) 100% more habitat assessments and 50% more species assessments under the Habitats Directive show an improved conservation status; and (ii) 50% more species assessments under the Birds Directive show a secure or improved status." (EU 2011).

Danish Natura 2000 plans have been adopted for SACs covering the habitats relevant for EU target 1 and management has already been ongoing for several years to improve their conservation status based on previous work and assessments (Larsen & Lentz 2016). For the PhD project it was therefore decided to focus on species, as only EU annex II species are directly covered by the Natura 2000 plans. Because species are linked to certain habitats, habitats were included indirectly via species.

Table 2 gives an overview of the 1932 Danish species which are listed as threatened on global or national red lists or listed on annexes to the EU nature directives: "2020-target-species". These species were the potential study species. If records were known / available from Denmark in the period 1991 - 2015 they were realized study species.

Table 2*. Overview of the 1932 species identified * (from chapter 4, tab. 4.)*

Taxon \ # species	DK_RE	DK_threatened	EU	Global_threatened	Total
Mammal	1	1	24		26
Bird	3	18	54	1	76
Reptile	1		1		2
Amphibian			11		11
Insect	142	498	7	7	654
Other invertebrate	1	21	5	2	29
Fungi	21	528		3	552
Lichen	96	293	7		396
Moss			41	1	42
Plant	22	108	14		144
Total	**287**	**1467**	**164**	**14**	**1932**

** A number of species are threatened at more than one geographic level. They are only listed in the table at the most global level. DK = Danish red list. RE = regionally extinct. Threatened comprises the categories critically endangered (CR), endangered (EN) and vulnerable (VU). EU species comprise annex 1 of the Birds Directive and annex II, IV and V of the Habitats Directive.*

The number of realized study species was 1371 in chapter 1, but 1378 in chapter 4 due to seven species of fungi, which were not identified as threatened from the start because of initially overlooked name mismatches between the database with red list status and the database with taxonomy. Of the 1378 realized study species 1066 occurred on Nature Agency lands, comprising 626 forest species (study species in chapter 2) and 440 non-forest species.

Chapter 4 - Possibilities for better achievement of 2020-targets for threatened species on Nature Agency lands.

This is the main industrial product of the PhD together with electronic data and GIS files delivered to the Nature Agency. The report (published 14th February 2018) includes for both forest and non-forest study species the background, data, methods, results, discussion, biases, recommendations, and conclusions of the work dealing with how to better achieve the 2020-targets for threatened species on Nature Agency lands. Most substance from chapters 1 and 3 is included more or less summarily, while the substance of chapter 2 is included in detail and folded out. A number of other issues relevant for practical conservation are discussed and recommendations given.

Species were split in priority 1 - 5 based on their reported status and trend, with priority 1 being globally threatened species, priority 2 and 3 threatened species reported in decline, and priority 4 and 5 being species with no reported decline and thus lower priority in relation to Aichi target 12. Priority 4 and 5 were grouped as priority class B (lower priority) while 1, 2 and 3 were taken as priority A (high priority).

One result from chapter 2 was that it was impossible in the Marxan analyses based on whole forests to reach target achievement for all species or for all priority A species. Chapter 4 therefore included further detailed GIS-analysis of species records and preferences at internal forest scale in order to further optimize target achievement. This showed that by zoning internally in less than 50 forests it is possible to provide all priority A species with relevant protection in all known sites for rare species (less than five sites in state forests), and in at least 5 sites for less rare species.

For non-forest species the analyses identified 370 sites on Nature Agency lands with priority A species which had missing or low protection by IUCN category 1-2 and the

Natura 2000 network in spite of hosting more than 1% of the national total of records 1991 - 2015 for the said species. These sites were listed and delivered with details to the agency in May 2017 in order to be included in planning the protection and conservation management for the sites.

Finally recommendations were given for practical conservation and management for forest and for open habitats separately based on the authors´ synthesis of cited literature, supplemented with unpublished experience from the implementation of the "Strategy for Natural Forests" (Anon. 1994), and with the analyses and results of the total work in all chapters. The recommendations for forests were related to the 2016 government decision to designate 10,000 ha of new untouched forests and 3,300 ha of "other biodiversity" forest reserves (Anon. 2016). The decision included a transitional period of 10 and 50 years respectively for deciduous and coniferous forest regions, so recommendations were divided in before and after the commencement of untouched (minimum-intervention) status.

A number of the recommendations relate to counteracting human-induced detrimental changes to ecosystem functions and structures over time, i.e. some of the reasons behind declines of threatened species are too many nutrients, too few large herbivores, too little deadwood, and much lower levels of fire and water in most of the landscape compared to more natural former time periods (figure 1).

	Nutrients	Large Herbivores	Deadwood	Water & fire
Interglacial	Natural	Many wild species	Natural	Natural
Mid-Holocene	Natural	Some wild species	Natural	Natural
1750-1850	Lower	Many domestic + hay	Very little	Lower
Now	Higher	Few (wild + domestic)	More but low	Much lower

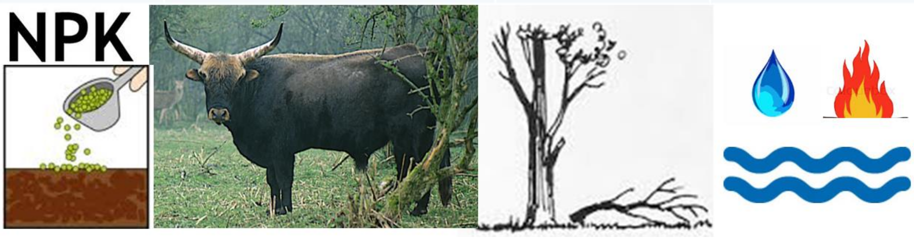

Figure 1. *An overview of some ecosystem functions and structures which have been changed by humans over time to the detriment of many now threatened species.*

It was concluded that Marxan with zones is a good but very data demanding tool to help cost-efficient selection of sites for biodiversity protection. The most cost-efficient solutions of the Marxan scenario runs selected an area of forest for untouched protection similar to the ambition level of new 10,000 ha in the government decision. On the other hand the area selected for other types of forest protection was higher than the 3,300 ha government target for "other biodiversity forest". A large proportion of the forest areas selected by Marxan for other types of forest protection were already protected in IUCN categories 1-4 (Dudley 2008) or based on species needing conifers, which should be able to be provided for in State Forests without necessarily being designated as "other biodiversity forest".

Depending on assumptions the economic costs of the most cost-efficient solutions varied between 38 and 46% of net annual income from wood harvest for the State Forests. This cost can be lowered and target achievement improved by zoning internally in forests with species showing opposing habitat preferences.

For open habitats it was concluded that a continued but more targeted approach to conservation management on Nature Agency lands should be done for a list of identified sites with priority species enjoying only low levels of protection. Also other sites for the same 33 listed species and for 277 nationally threatened species in decline should be given high priority. This large number of species can be difficult to cope with at national level, but at forest level the species number is always low (ten or less), so management can go into more detail for each species and target management.

Appendix I - Where are Europe´s last primary forests?

This article was the result of an invitation from the lead author Francesco Sabatini to contribute to his work on building a database and overview of primary forests in Europe. It has been in peer-review for Diversity and Distributions, and has been invited for resubmission after revisions.

Primary forests, in short being naturally regenerated forests of native species where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed, are becoming rare as forestland globally is cleared for agriculture or put under active management (Mackey et al. 2015; Potapov et al. 2017). Given their irreplaceability and unique qualities, protecting primary forests is a global concern (Mackey et al. 2015). Not only are they cherished for their wild nature (Navarro & Pereira 2012) and represent a social perception of untouched nature (Schnitzler 2014), they are also ecologically important in regions where forests are highly fragmented (Vandekerkhove et al. 2009).

Several more or less concise definitions exist for primary forest. For the purpose of getting an objective overview and database for Europe, it was decided to use the hierarchical terminology on more or less natural forests developed by Buchwald (2005). The aim was to i) compile the first European-scale map of known primary forests, ii) analyze the spatial determinants characterizing their location, and iii) locate areas where as yet unmapped primary forests are likely to occur. We aggregated data from a literature review, online questionnaires, and 32 datasets of primary forests. Boosted regression trees were used to explore which biophysical, socioeconomic and forest-related variables could explain the current distribution of primary forests. Finally, the relative likelihood of primary forest occurrence at a 1-km resolution across all of Europe was predicted and mapped.

Data on primary forests were frequently incomplete or inconsistent among countries. Known primary forests covered 1.4 Mha in 32 countries (0.7% of Europe’s forest area). Most of these forests were protected (89%), but only 46% of them strictly. Primary forests mostly occurred in mountain and boreal areas, and were unevenly distributed across countries, biogeographical regions, and forest types. Unmapped primary forests likely occur in the least accessible and populated areas, where forests cover a greater share of land but wood demand historically has been low.

The current distribution of primary forests is the result of centuries of land-use dynamics and forest management. The conservation outlook for these forests is uncertain, however, since their small and fragmented patch structure makes them prone to extinction debt and human disturbance. Predicting where unmapped primary forests likely occur could aid protection efforts and prevent further loss.

Appendix II - Development in the number of breeding bird species in Denmark 1800-2012

This article resulted from a contact from me to the three other authors who in 2013 presented a paper in the Birdlife Denmark journal (Romdal et al. 2013) on development in the numbers of species of Danish breeding birds 1800-2012. I had noted problems in their data which made re-analysis of an updated extended dataset relevant. The authors and the journal editor agreed this was necessary and I helped getting the data-set, article, and conclusions right and up-to-date, which resulted in new categorization for eight species.

The updated results confirmed that numbers of breeding bird species in Denmark increased significantly from 149 in 1800 to 178 in 2012. Split into habitat types, the new results showed a continued increase in numbers of species in forest and wetland habitats in recent years in contrast to results in the first article (Romdal et al. 2013).

The largest decline in species numbers occurred within the group heathland /meadow /commons. The general stagnation in species richness reported in the last 20 years by Romdal et al. (2013) was not supported. The number of non-persecuted species, however, did show a statistically significant decline in the last 20 years. By contrast, the species categorized as (previously) persecuted increased significantly in the revised analysis over the last 20 years – indicating a comeback from an all-time low around 1900.

Enhanced legal protection, landscape change, nature management, and a change in mindset among the general public are believed to be some of the major drivers contributing to the long term increase in Danish bird species richness.

Appendix III - Where should we do what in State Forests?

As a kick-off presentation of the industrial PhD-project this article was published in 2015 in a thematic issue of moMentum+ on Biodiversity and Forest. The idea and objectives of the PhD-project were presented and some preliminary analyses; among others that forest species comprise an absolute majority of threatened species, but that relatively less forest species are threatened compared to species of more open habitats like grasslands, wetlands, and heaths etc. (Table 3).

Table 3. *Overview of species with habitat information in the Danish red list database (Wind & Pihl 2010).*

# species per habitat	Regionally extinct (RE)	Threatened (CR, EN, VU)	Near threatened (NT)	Least concern (LC)	Data deficient (DD)	Total
Forest species	137	881	240	3322	446	5026
Non-forest species	152	645	192	1842	175	3006
Total	289	1526	432	5164	621	8032
Percentages						
% of forest species	2.7	17.5	4.8	66.1	8.9	100.0
% of non-forest species	5.1	21.5	6.4	61.3	5.8	100.1

Perspectives

The analyses and results of this study became a significant part of the basis for the new State Forests proposed for protection as implementation of the 2016 "Nature-package" decision. The proposal was publicly announced on February 2nd 2018 (Anon. 2018). It included more than 13,300 ha of new protected biodiversity forests, with a very great overlap to the most cost-effective forest selections resulting from solutions in chapter 2 and 4. The "Nature Package" also includes actions and subsidies for forest biodiversity in non-state forests with a target level of 3,300 ha new protected forests.

Table 3 and Appendix II are in line with the general picture (e.g. Ejrnæs et al. 2010; Petersen et al. 2012) that decline of biodiversity in Denmark is also a major problem in open semi-natural habitats like grasslands and heaths, and in the agricultural landscape in general. In view of the major new effort for forest biodiversity the more open habitats would seem to be a good candidate for a similar evidence-based and systematic conservation planning effort including non-state lands.

Of the 1378 threatened species recorded 1991-2015 in Denmark, 312 species were only recorded outside State Forest areas, while 74 species were only recorded in State Forest areas. The nation-wide quality-assured dataset generated by the project with occurrences of all threatened species 1991-2015 has been published on GBIF, so it can be incorporated in other types of studies. The occurrence dataset could e.g. be used by authorities or nature protection organizations for more evidence-based planning and prioritization of actions all over Denmark for both forest and non-forest species. For a successful national protection regime conservation action is necessary across ownership categories.

Fortunately not all is decline for biodiversity. Actions to reverse trends do help, as e.g. shown in Appendix II for previously persecuted birds, for birds in general and most significantly for forest birds. A very recent positive sign that conservation actions in Danish forests have in the last 25 years also helped other threatened species, regards fungi dependent on dead wood, as several of them are noted to have increased significantly in that period attributed to higher amounts of dead wood in some forests (Heilmann-Clausen et al. 2018). With the decided major increase in protected State Forest areas based on data for all threatened species in Denmark I am convinced that forest biodiversity in Denmark will thrive even more!

The Nature Agency has offered me to continue work on these issues after my PhD dissertation by using the results and detailed knowledge from the PhD project in the actual planning and implementation of conservation and protection of the new designated biodiversity forests. This makes it possible to make best use of the large amount of data generated in the project to the benefit of protection of our threatened species. I feel grateful having been given this chance to make a difference and improve chances of halting the decline in biodiversity.

References

Anonymous (1994). Strategy for natural forests and other forest types of high conservation value in Denmark. The Ministry of Environment, The National Forest and Nature Agency. 48 pp.

Anonymous (2016). Nature Package Agreement (in Danish), Ministry of Environment and Food of Denmark. http://mfvm.dk/fileadmin/user_upload/Natturpakke-2016.pdf

Anonymous (2018). Designation of forest for biodiversity (in Danish: Udpegning af skov til biodiversitetsformål). 38 pp. http://naturstyrelsen.dk/media/230273/udpegning-af-skov-til-biodiversitetsformaal.pdf (accessed 22nd January 2018).

Battisti, C. & Fanelli, G. (2015). Don't think local! Scale in conservation, parochialism, dogmatic bureaucracy and the implementing of the European Directives. Journal for Nature Conservation 24:24-30.

Bernes, C., Jonsson, B. G., Junninen, K., Lõhmus, A., Macdonald, E., Müller, J., & Sandström, J. (2015). What is the impact of active management on biodiversity in boreal and temperate forests set aside for conservation or restoration? A systematic map. Environmental Evidence, 4(1), 25.

Brunet, J., Fritz, Ö., & Richnau, G. (2010). Biodiversity in European beech forests–a review with recommendations for sustainable forest management. Ecological Bulletins, 53(7).

Buchwald, E., (2005). A hierarchical terminology for more or less natural forests in relation to sustainable management and biodiversity conservation, Proceedings: Third expert meeting on harmonizing forest-related definitions for use by various stakeholders. Food and Agriculture Organization of the United Nations, Rome, 17-19 January 2005.

CBD (2010). COP 10 Decision X/2. Strategic Plan for Biodiversity 2011-2020. https://www.cbd.int/decision/cop/?id=12268

Dirzo, R., Young, H. S., Galetti, M., Ceballos, G., Isaac, N. J., & Collen, B. (2014). Defaunation in the Anthropocene. science, 345(6195), 401-406.

Dudley, N. (Editor), (2008). Guidelines for Applying Protected Area Management Categories. Gland, Switzerland. IUCN. 86pp.

Ejrnæs, R., Wiberg-Larsen, P., Holm, T.E., Josefson, A., Strandberg, B., Nygaard, B., Andersen, L.W., Winding, A., Termansen, M., Hansen, M.D.D., Søndergaard, M., Hansen, A.S., Lundsteen, S., Baattrup-Pedersen, A., Kristensen, E., Krogh, P.H., Simonsen, V., Hasler, B. & Levin, G. (2011). Danmarks biodiversitet 2010 – status, udvikling og trusler. Danmarks Miljøundersøgelser, Aarhus Universitet. 152 sider – Faglig rapport fra DMU nr. 815.

EU (1979). Council Directive of 2 April 1979 on the conservation of wild birds (79/409/EEC). Official J. Eur. Communities, (L103).

EU (1992). Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Union, 206, 7-50.

EU (2011). Our life insurance, our natural capital: an EU biodiversity strategy to 2020. Communication from the Commission. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0244

Evans D. (2012). Building the European Union’s Natura 2000 network. Nature Conservation 1: 11–26. doi:10.3897/natureconservation.1.1808 .

Heilmann-Clausen, J., Jeppesen, T.S., Læssøe, T., Petersen, J.H., Frøslev, T.G. & Søchting, U. (2018). News from the Danish Fungal Atlas 2017. [in Danish with English abstract]. Svampe 77: 9-19.

Johannsen, V. K., Dippel, T. M. , Møller, P. F. , Heilmann-Clausen, J., Ejrnæs, R., Larsen, J. B., Raulund-Rasmussen, K., Rojas, S. K., Jørgensen, B. B., Riis-Nielsen, T., Bruun, H. H. K., Thomsen, P. F., Eskildsen, A., Fredshavn, J., Kjær, E. D., Nord-Larsen, T., Caspersen, O. H., Hansen, G. K. (2013). Evaluering af indsatsen for biodiversiteten i de danske skove 1992-2012. KU/IGN, 90 pp.

Larsen, E.L., & Lentz, C. B. (2016). What is the economy in the Natura 2000 plans for 2016-2021? [in Danish] Miljø- og Fødevareudvalget 2015-16, MOF Alm. del endeligt svar på spørgsmål 810, http://www.ft.dk/samling/20151/almdel/mof/spm/810/svar/1320835/1627535/index.htm .

Lindenmayer, D. B., & Franklin, J. F. (2002). Conserving forest biodiversity: a comprehensive multiscaled approach. Island Press.

Lund, M.P. (2002). Performance of the species listed in the European Community 'Habitats' Directive as indicators of species richness in Denmark. Environmental Science & Policy 5:105-112.

Lund, M.P. & Rahbek, C. (2002). Cross-taxon congruence in complementarity and conservation of temperate biodiversity. Animal Conservation 5:163-171.

Lundström, J., Öhman, K., Rönnqvist, M., & Gustafsson, L. (2016). Considering future potential regarding structural diversity in selection of forest reserves. PloS one, 11(2), e0148960.

Mackey, B., DellaSala, D.A., Kormos, C., Lindenmayer, D., Kumpel, N., Zimmerman, B., Hugh, S., Young, V., Foley, S., Arsenis, K. & Watson, J.E.M. (2015). Policy Options for the World's Primary Forests in Multilateral Environmental Agreements. Conservation Letters, 8, 139-147.

Maiorano, L., Amori, G., Montemaggiori, A., Rondinini, C., Santini, L., Saura, S. & Boitani, L. (2015). On how much biodiversity is covered in Europe by national protected areas and by the Natura 2000 network: insights from terrestrial vertebrates. Conserv. Biol. 29:986-95.

Margules, C. R., & Pressey, R. L. (2000). Systematic conservation planning. Nature, 405(6783), 243.

Moilanen, A., Wilson, K. A., & Possingham, H. (2009). Spatial conservation prioritization: quantitative methods and computational tools (pp. 1-304). Oxford University Press.

Navarro, L.M. & Pereira, H.M. (2012). Rewilding abandoned landscapes in Europe. Ecosystems, 15, 900-912.

Newbold, T., Hudson, L. N., Hill, S. L., Contu, S., Lysenko, I., Senior, R. A., ... & Day, J. (2015). Global effects of land use on local terrestrial biodiversity. Nature, 520(7545), 45-50.

Peterken G. (1996). Natural Woodland: Ecology and Conservation in Northern Temperate Regions. Cambridge (MA): Cambridge University. 522 pp.

Petersen, A.H, Strange, N., Anthon, S., Bjørner, T.B. & Rahbek, C. (2012). Bevarelse af biodiversite-ten i Danmark. En analyse af indsats og omkostninger. Arbejdspapir 2012:2. De Økonomi-ske Råd. 107 sider.

Petersen, A. H., Lundhede, T., Bruun, H. H., Heilmann-Clausen, J., Thorsen, B. J., Strange, N., & Rahbek, C. (2016). Bevarelse af biodiversiteten i de danske skove: en analyse af den nødvendige indsats, og hvad den betyder for skovens andre samfundsgoder. Center for Macroecology, evolution and Climate. University of Copenhagen. 113 pp.

Pimm, S. L., Jenkins, C. N., Abell, R., Brooks, T. M., Gittleman, J. L., Joppa, L. N., ... & Sexton, J. O. (2014). The biodiversity of species and their rates of extinction, distribution, and protection. Science, 344(6187), 1246752.

Potapov, P., Hansen, M.C., Laestadius, L., Turubanova, S., Yaroshenko, A., Thies, C., Smith, W., Zhuravleva, I., Komarova, A., Minnemeyer, S. & Esipova, E. (2017). The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013. Science Advances, 3

Romdal, T.S., Dinesen, L. & Grell, M.B. (2013). Development in the number of breeding bird species in Denmark 1800-2012 (in Danish with an english abstract). Udviklingen i antallet af ynglende fuglearter i Danmark 1800-2012. – Dansk Orn. Foren. Tidsskr. 107: 281-290.

Schnitzler, A. (2014). Towards a new European wilderness: Embracing unmanaged forest growth and the decolonisation of nature. Landscape and Urban Planning, 126, 74-80.

Segan, D. B., Game, E. T., Watts, M. E., Stewart, R. R., & Possingham, H. P. (2011). An interoperable decision support tool for conservation planning. Environmental Modelling & Software, 26(12), 1434-1441.

van der Sluis, T., Foppen, R., Gillings, S., Groen, T., Henkens, R., Hennekens, S., Huskens, K., Noble, D., Ottburg, F., Santini, L., Sierdsema, H., van Kleunen, A., Schaminee, J., van Swaay, C., Toxopeus, B., de Vries, M.W., & Jones-Walters, L. (2016). How much Biodiversity is in Natura 2000? The “Umbrella Effect” of the European Natura 2000 protected area network. Alterra report 2730B, Wageningen, The Netherlands.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Folke, C. (2015). Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223), 1259855.

Vandekerkhove, K., De Keersmaeker, L., Menke, N., Meyer, P. & Verschelde, P. (2009). When nature takes over from man: Dead wood accumulation in previously managed oak and beech woodlands in North-western and Central Europe. Forest Ecology and Management, 258, 425-435.

Venter, O., Fuller, R. A., Segan, D. B., Carwardine, J., Brooks, T., Butchart, S. H., ... & Possingham, H. P. (2014). Targeting global protected area expansion for imperiled biodiversity. PLoS Biology, 12(6), e1001891.

Venter, O., Magrach, A., Outram, N., Klein, C. J., Marco, M. D., & Watson, J. E. (2017). Bias in protected-area location and its effects on long-term aspirations of biodiversity conventions. Conservation Biology.

Watson, J. E., Darling, E. S., Venter, O., Maron, M., Walston, J., Possingham, H. P., ... & Brooks, T. M. (2016). Bolder science needed now for protected areas. Conservation Biology, 30(2), 243-248.

Watts, M. E., Steinback, C. & C. Klein, (2008). User Guide: Applying Marxan with Zones. North central coast of California marine study. University Of Queensland.

Watts, M. E., I. R. Ball, R. S. Stewart, C. J. Klein, K. Wilson, C. Steinback, R. Lourival, L. Kircher & H. P. Possingham, (2009). Marxan with Zones – software for optimal conservation-based land- and sea-use zoning. Environmental Modelling & Software 24:1513-1521.

Wilson, K. A., Meijaard, E., Drummond, S., Grantham, H. S., Boitani, L., Catullo, G., ... & Watts, M. (2010). Conserving biodiversity in production landscapes. Ecological Applications, 20(6), 1721-1732.

Wind, P. & Pihl, S. (eds.), (2010). The Danish Red List. The National Environmental Research Institute, Aarhus University. redlist.dmu.dk (updated April 2010).

CHAPTER 1

How well do conservation sites based on annex II species of the EU Habitats Directive cover other threatened species relevant for the 2020 biodiversity targets?

Erik Buchwald & Jacob Heilmann-Clausen

(In preparation for Biological Conservation)

Previous page: Aporia crataegi and Adscita statices (photo by Erik Buchwald)

How well do conservation sites based on annex II species of the EU Habitats Directive cover other threatened species relevant for the 2020 biodiversity targets?

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Abstract

Political targets for protection of biodiversity have been accepted at global and EU (European Union) levels for the year 2020. Networks of protected areas (PAs) have been designated which are supposed to deliver on the targets. PAs are often designated based on proxy data surrogating total biodiversity, e.g. data on abiotic environmental or on a set of pre-defined indicator species. In many cases it remains an open question if such PA networks cover more than the proxies they were based on. This is not least the case for subtle and less well-known parts of threatened biodiversity. In this study we investigated the performance of EU Habitats Directive Annex II species as indicators of threatened species in site selection, and evaluated the effectiveness of actual PAs using complementarity based algorithm-optimization and gap analysis. We found that the Danish Special Areas of Conservation (SACs) which were selected based on a limited number (n=27) of EU Habitats Directive Annex II species had a much higher coverage (42 – 64%) of all known occurrences of threatened species (n=1344) than expected based on the SAC coverage of Denmark (8.6% of land area). This applied for both internationally (n=137) and nationally (n=1207) threatened species including less studied groups like fungi (n=513), mosses (n=35) and spiders (n=17). In total, 88% of all threatened species occurred in at least one SAC. All other EU countries have designated more of their country than Denmark as Natura 2000 (including SACs). As the countries have had to follow the same principles of designation laid down in the Habitats Directive, a similar or higher coverage of threatened species is expected in those countries. Designation of PAs on the basis of multi-taxon species proxies is thus recommended as being efficient. This is in line with other studies, even though few have documented as high efficiency as here.

Keywords

Denmark, Natura 2000, gap analysis, protected areas, IUCN, indicator species, red list, SAC.

Introduction

The 1992 United Nations Convention on Biological Diversity (CBD) set ambitious goals to protect life on Earth. Its Strategic Plan for Biodiversity 2011–2020 further details 20 so-called Aichi Biodiversity Targets including target 12 aiming at preventing extinction of threatened species (CBD 2014). However a review of progress (Tittensor et al. 2014) argued that target 12 and many other targets are unlikely to be met unless efforts to meet targets increase.

At the European Union (EU) level the implementation of the 'Habitats Directive' (directive 92/43/EEC) adopted in 1992 is one major effort to deliver on the CBD and Aichi targets, together with the 'Birds Directive' 79/409/EEC from 1979. The EU has specified 6 biodiversity targets which to a high degree relate to implementation of those two directives. The EU targets have been evaluated mid-term by the European Environment Agency (EEA 2015) similarly showing that more effort is needed because a high proportion of species and habitats have an unfavorable conservation status.

A major part of the efforts from the Habitats Directive targets management and conservation of Special Areas of Conservation (SACs) as part of the Natura 2000 network (Evans 2012; Maiorano et al. 2015). The SACs were selected as sites with occurrence of species listed on Annex II of the directive or on the basis of presence of threatened or characteristic habitats listed on Annex I (Battisti & Fanelli 2015; van der Sluis et al. 2016). The Annex II species were chosen when drafting the directive annexes as a subset of red listed species assessed to benefit from site protection in contrast to species protection (Cardoso 2012; Lund 2002). But it remains an open question if sites designated based on a limited number of focal species also cover other taxon groups and biodiversity in general, and more specifically if they cover threatened species relevant for the 2020 biodiversity targets (Cardoso 2012; Maiorano et al. 2015; Petersen et al. 2016; Rodrigues & Brooks 2007).

The question has been studied at EU level, based on analysis of Natura 2000 site overlap with distribution maps of species (Sluis et al. 2016; Trochet and Schmeller 2013) showing that several countries and taxon groups had significantly higher effectiveness than if a similar Natura 2000 area had been chosen at random. Surprisingly other countries and taxon groups had lower coverage than expected by chance. This is surprising because Natura 2000 sites were chosen to cover the largest and best nature areas representing a large number of habitats and species, while areas outside Natura 2000 generally have more intensive land-use and infrastructure less suited for natural habitats and species (Evans 2012; Petersen et al. 2016).

It is concerning if the designated Natura 2000 sites do not cover a significantly higher than random proportion of globally / nationally threatened species, because nature management resources are highly directed towards Natura 2000 sites in much of the EU.

Lund (2002), in an analysis of species representation (instead of area coverage) showed that species listed in Annex II of the Habitats Directive performed well as indicators of other species in site selection based on complementarity – at least in Denmark. Indeed the effectiveness of the then proposed Sites of Conservation Interest (pSCIs) based on Annex II species at representing other Danish species was found to be "equivalent to the effectiveness of the near-optimal solution" and significantly better than random. The study of Lund (2002) was based on 761 species (including 262 nationally red listed species) of orchids, club mosses, bats, birds, amphibians, reptiles and five groups of insects. Due to data limitations several questions remained unresolved, e.g. would the conclusion hold true also for threatened species in general and for taxon groups not included, like fungi and lichens, and would the relatively weak representation of orchids be representative of other plants?

Since 2002 the then proposed 194 Danish pSCI sites have been finalized and supplemented with more sites so that a total of 261 SACs are now designated. The fact that Danish and EU funding for nature protection has very high focus on Natura 2000 including SAC, might potentially lead to less funding for globally or nationally threatened species if these are not in the SAC areas. Much more detailed species occurrence data has been obtained in Denmark since Lund (2002), so that some of her unresolved questions, e.g. effect of inclusion of other taxonomic species groups, of data on more plant species or effect of better site-scale data may now be addressed.

In this paper we re-used the tests and methods recommended by Lund (2002) and several other authors (e.g. Petersen et al. 2016; Rodrigues & Brooks 2007) to assess how well EU Annex II species (listed in the Habitats Directive and used for designation of SACs) represent nationally and globally threatened species based on principles of complementarity.

In addition we performed a gap-analysis to study how well the network of SACs in Denmark covers species threatened at global, EU and national level respectively. In order to be comparable to previous studies (Sluis et al. 2016; Trochet and Schmeller 2013) the null-hypothesis was chosen to be that Annex II species are no better than random at representing other species groups and that their coverage is therefore no larger than the percentage of Danish area designated. It should be noted that this null-hypothesis is not optimal because it is unlikely to be met in countries with a large agricultural area (like Denmark) if SAC designation as expected primarily occurs in less heavily influenced areas of the country.

Finally we compared grid-cell-based versus polygon-based analyses of species coverage to assess the bias introduced by using coarse spatial data, and assessed the proportion of threatened species not covered by SACS covered by other types of nature protection in Denmark.

The present study is novel by using comprehensive detailed presence data instead of assumed presence extrapolated from largescale range maps often at 50 x 50 or 10 x 10 km scale, and by including all species and taxonomic groups threatened at either global, EU or national level in Denmark, and finally by being an integral part of the governmental designation process of new reserves. The government has decided to designate 10 000 ha of new minimum-intervention forest reserves and more than 3000 ha of other forest reserves to better preserve Danish forest biodiversity (Anon. 2016a). The findings of this and other studies were included to direct which areas to prioritize in the new selection process.

Methods

Study area

Denmark covers 43 100 km^2 in NW Europe and is highly influenced by agriculture and other human activities. More than 62% of the area is used for agriculture while forests cover 14%, cities and infrastructure 10%, and semi-natural biotopes like grassland and heaths 9% (Anon. 2016b).

Denmark has designated 261 marine and non-marine SACs based on occurrences of Annex II species and Annex I habitats. The non-marine parts cover 8.61% of Denmark (n=163). The selection process was undertaken in 1994-2006 using analogue traditional data on occurrences of Annex II species and Annex I habitats and without access to the much more complete, detailed and updated data collated in the present study. The selection process did not include consideration of other threatened species than those listed on Annex II (Lars Rudfeld pers. comm.).

Using a not totally precise method to distinguish terrestrial from marine sites, EEA (2016) has listed Denmark as the EU country with the lowest proportion of terrestrial area (8.3%) covered by Natura 2000 sites. According to EEA (2016) the terrestrial Natura 2000 cover in other EU countries (excluding Brexit UK) range from 11.5 (Latvia) to 37.9% (Slovenia). These figures include both SACs and SPAs (Special Protection Areas for birds).

Data

Study species (N = 1371) were delimited as being terrestrial or amphibious species known from Denmark, and being globally (IUCN 2015) or nationally (Wind & Pihl 2010) red-listed in the high threat categories (RE, CR, EN, VU), plus birds listed on Annex I of the EU Birds Directive and species listed on annexes II, IV or V of the EU Habitats Directive. These species are collectively referred to as threatened. Taxonomy and naming was updated to match the standard species checklist of Denmark maintained by the Danish Biodiversity Information Facility (DANBIF 2016).

Species occurrence records were collected and compiled from all relevant sources available in digital formats (more than 22 million records from e.g. ministry databases, NGO citizen science databases and university & museum databases) supplemented by a few detailed inventory studies on beetles, spiders or lichens which were digitized as part of the project (Table A1, electronic suppl. mat.). Only records regarding the study species were used and only if data on at least year and detailed locality were recorded or could easily be extracted from supplementary information.

In order to use as up-to-date occurrences as possible without leaving out too many overlooked extant occurrences, records from the last 25 years were used (1991-2015). For birds only certain and probable breeding records were used, delimited by the methods applied in the Danish Breeding Bird Atlas I, II & III regarding activity type and dates of breeding season (Anon. 2015; Dybbro 1976; Grell 1998).

Records living up the above criteria were stratified according to how precise the locality was delimited and identified. UTM coordinates of the center of observation were used for precise GPS records and based on locality name for other records. Locality names and coordinates were cross-checked and corrected for records with more than one type of locality information. Locality names were standardized for typing errors etc. and extended with municipality name in order to separate synonymous names. Up to 15 different sites had the same name, e.g. Nørreskov (Northwood), which in some cases had led to wrong automatic coordinates being applied by some data providers.

The data providers had varying levels of quality assurance of their data, so records were scrutinized as an extra quality control with focus on regionally extinct and very rare species without proper documentation, and on uncertain or inaccurate localities. More than 1500 records for study species were thus excluded and a similar number corrected. Examples include an almost extinct lake-bottom plant noted from forest floor, and long extinct species recorded outside potential range/habitats and without having comments proving their validity or being published in other ways. The errors were documented in the files with comments on excluded records.

Finally the dataset (N= 267 064) was uploaded to GBIF (Buchwald 2018). Other GBIF species records for Denmark (n=10 245 635, Table A2, suppl. mat.) were checked, but not used due to being either redundant to more detailed data acquired from the original sources (87%), having locality precision issues (11%), being datasets for non-study-species (1%) or lacking year (1%).

Using GIS ArcView the resulting data records were assigned to the 261 SACs and 633 UTM 10 x 10 km grid cells of Denmark (UTM ETRS 1989 zone 32/33N) and to other nationally designated protected areas matching IUCN protection categories I-IV. GIS-data for SACs were from the European Environmental Agency (EEA 2016), while nationally protected areas were 2016 versions of GIS-files of the Danish Nature Agency.

Analysis methods

A rarity-based heuristic algorithm was used to select priority sets of complementary areas in order to maximize representation of different species given e.g. a certain amount of grid cells or a given total area to be protected (WORLDMAP software, Williams 1999). Similarly areas can be selected for a certain minimum number of representations of each species.

A "near-minimum" set was assigned as a minimum set of 10 x 10 km grid cells needed to represent all EU Annex II species 5 times. This "near-minimum" set was then checked for number of representations of internationally / nationally threatened species and compared with the number of representations which could have been included with the same amount of grid cells chosen optimally ("Near-maximum-coverage" analysis, Williams 1998). Annex II species were excluded in the lists of internationally / nationally threatened species to avoid them being both indicator and target (Rodrigues & Brooks 2007). Internationally threatened species were only included as such, even though many of them are also on the national red-list as threatened.

By running 1000 random selections (without replacement) of a fixed amount of grid cells, minimum acceptable effectiveness was assessed. For a focal group to be considered a reliable indicator its performance was required to be better than delimited by the upper 95% confidence limit achieved by 1000 random area selection runs (Araujo 2004; Lund 2002; Lund & Rahbek 2002; Rodrigues & Brooks 2007).

Efficiency of the Danish SAC designation and coverage of species was assessed by Gap Analysis (Oldfield et al. 2004; Powell et al. 2000; Scott et. al. 1993) of the 163 non-marine SACs. A 'SAC set' of grid cells was developed for this purpose: For SACs totally included in one grid cell, that grid cell was included in the 'SAC set'. SACs crossing grid cell borders included only one grid cell in the 'SAC set' if that grid cell included all of the Annex II species present in the SAC. When necessary to represent all Annex II species occurring in a SAC, two or three grid cells were included (Lund 2002). Totally 172 grid cells of 10 x 10 km were thus included in the 'SAC set'. Near-maximum-coverage and random analyses were re-run as described above.

For comparison with the 'SAC set' an "optimal location solution" for a similar number of grid cells was found using Near-maximum-coverage analysis that maximizes the number of representations of Annex II species. Lund (2002) described the above methods in detail.

Coverage of species by protected areas was finally assessed at precise scale based on GIS-analysis of the detailed species occurrence data using polygon data for SACs and other Danish protected areas matching IUCN protection categories I-IV (Dudley 2008).

ANCOVA was used to compare mean coverage of the taxon- and threat-groups and to compare with the national percentage of designated SACs. ANCOVA was used instead of ANOVA because coverage was significantly influenced by the covariate species commonness. Linear models were thus fitted for each species group to the relationship between coverage (% of occurrences in SAC polygons) and number of occupied grid cells (log-transformed). Covariate slopes were also compared using ANCOVA. Reptiles and amphibians were pooled with mammals to "other vertebrates" in the statistical analyses because they had small species numbers (N = 1 and 11). Statistical analyses were performed using R (R Core Team 2015) including package ggplot2 for graphics (Wickham 2009). Standard significance level of 95% was used.

Results

The 27 Annex II study species were distributed widely and rather evenly across Denmark, with somewhat lower density in the sandy outwash plains of western Denmark (Fig. 1a). Only 18 of the 633 Danish 10 km grid cells were without any records of target species while eight grid cells were hotspots with seven to eight of the 27 species. The distributions of internationally (N = 137, Fig. 1b) and nationally threatened (N = 1207, Fig.1c) species showed other patterns with relatively more records from islands and coasts, and less from the central southern part of Denmark. The most species rich grid cells for the three groups showed only limited overlap, e.g. only one grid cell from the Annex II top-ten overlapped with top-ten for the 1207 nationally threatened species, and only two with top-ten for the 137 internationally threatened species (Fig.1a,b,c).

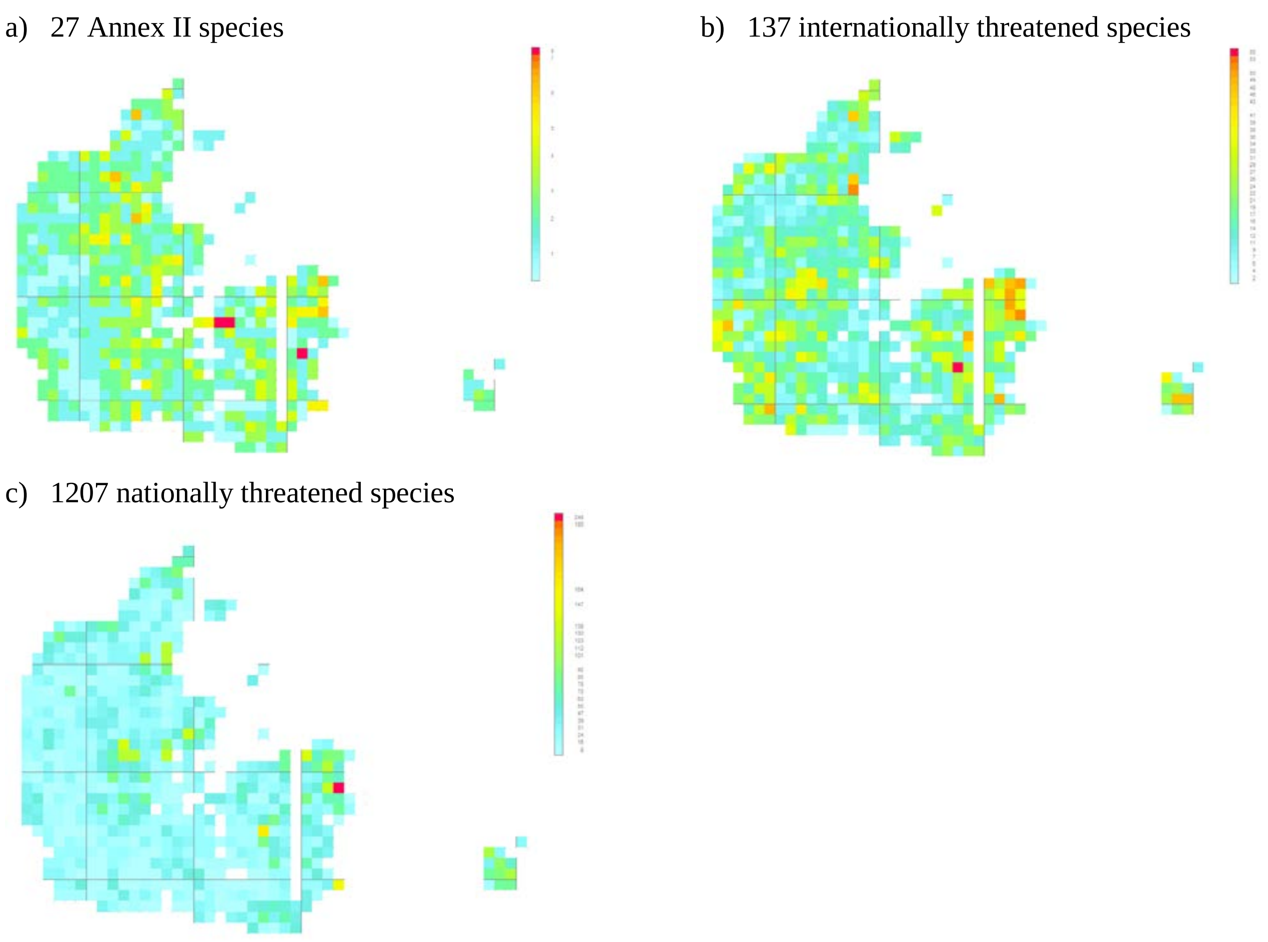

Fig. 1. Species richness patterns of a) Annex II species, n=27, b) internationally threatened species not on Annex II, n=137 and c) nationally threatened species not included in a) or b), n=1207. Red color indicates maximum richness [a) 8 species, b) 55 species, c) 248 species] while light blue is minimum [1, 2 and 8 respectively]. White is sea or UTM zone border in c) but includes zero species in a) and b).

Annex II species as indicators

In spite of the differing distribution patterns, the 49 grid cells selected based on complementarity for Annex II species ('Annex II set') represented the other groups significantly better than random with 86.1% of the internationally and 65.8% of the nationally threatened species represented (Fig. 2a - b). The median random solution would only have represented 77.5% and 44.0% respectively, so the difference is not just statistically significant, but also quite large, meaning that the Annex II species were effective as indicators of grid cells with other threatened species. Six of the globally threatened species were represented four to five times in the 49 grid cells, while the two most rare species were unrepresented (Table 1).

Table 1. Representations (reps) of globally threatened species which are not also EU Annex II-species.

Species name	Total number of 10km grid cell presences	Reps in 49 grid cells 'Annex II set'	Reps in 172 grid cells 'SAC set'	Presence records in-/outside SAC polygons
Ampedus hjorti (beetle)	21	5	14	33 / 32
Formicoxenus nitidulus (ant)	14	4	11	18 / 8
Phyllodesma ilicifolia (moth)	32	4	13	80 / 151
Dolomedes plantarius (spider)	6	4	5	37 / 2
Hygrocybe citrinovirens (fungus)	19	4	11	29 / 38
Hygrocybe ingrata (fungus)	29	4	14	56 / 75
Tricholoma acerbum (fungus)	3	0	0	0 / 21
Podiceps auritus (bird)	2	0	0	4 / 1

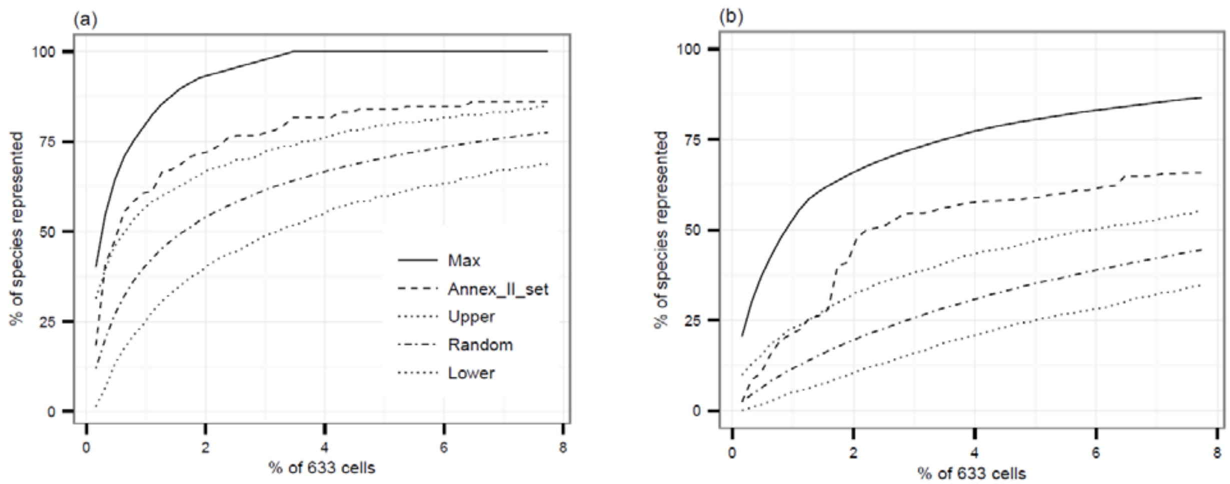

Fig. 2. Percentage of internationally (a, n=137) and nationally (b, n=1207) threatened species represented by 49 grid cells optimized for five representations of Annex II species ('Annex_II_set'), compared to the 'near-maximum' solution (Max) and to 49 grid cells chosen at random (random median with upper and lower 95% confidence limits from 1000 draws). 49 grid cells correspond to 7.7% of 633 Danish grid cells (10 x 10 km).

Performance of the realized SACs at grid cell scale

All Annex II species (n=27) were represented at least once in the 'SAC set' (Table A3, supplementary material). Assuming a conservation target of at least one representation of all other threatened species (n=1344), the 'SAC set' performed significantly better than the random selection, (representing 88.1% and 75.7% of the species respectively) but also better than the solution optimized for maximum representation of Annex II species which represented 85.7% of target species - the 'optimal set' (Fig. 3).

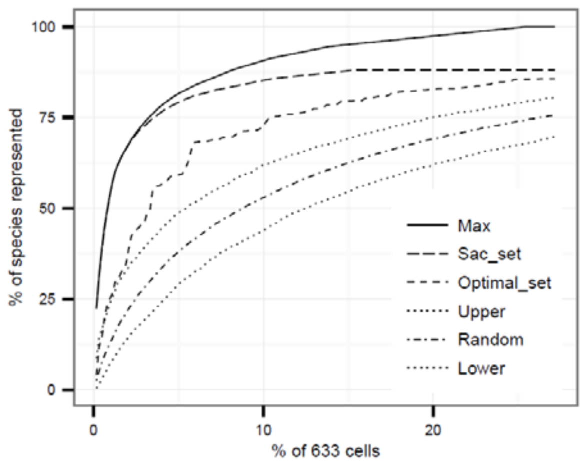

Fig. 3. Percentage of all threatened species except Annex II (n=1344) represented by 172 grid cells covering the 163 non-marine SACs (Sac_set), compared to the 'near-maximum' solution (Max), to the 'Optimal set' based on Annex II species, and to 172 grid cells chosen at random (random median with upper and lower 95% confidence limits from 1000 draws). 172 grid cells correspond to 27.2% of 633 Danish grid cells (10 x 10 km).

Most study species (70.2%) had multiple representations in the 'SAC set' (Fig. 4; Table A3, supplementary material) while zero representation ("gap species") was the case for 160 species (11.9%) including 112 'one-grid-cell' species. In total 15.6% of the 1344 threatened species were recorded from only one grid cell. The gap species included some which have had an ephemeral occurrence, e.g. only showing breeding behavior for one or a few years despite being easily recorded, and other species being only recorded once due to detection problems and/or extreme rarity. In all respects the 'SAC set' performed better than the 'optimal set' by having more species represented multiple times and less species represented only once or not at all (Fig. 4).

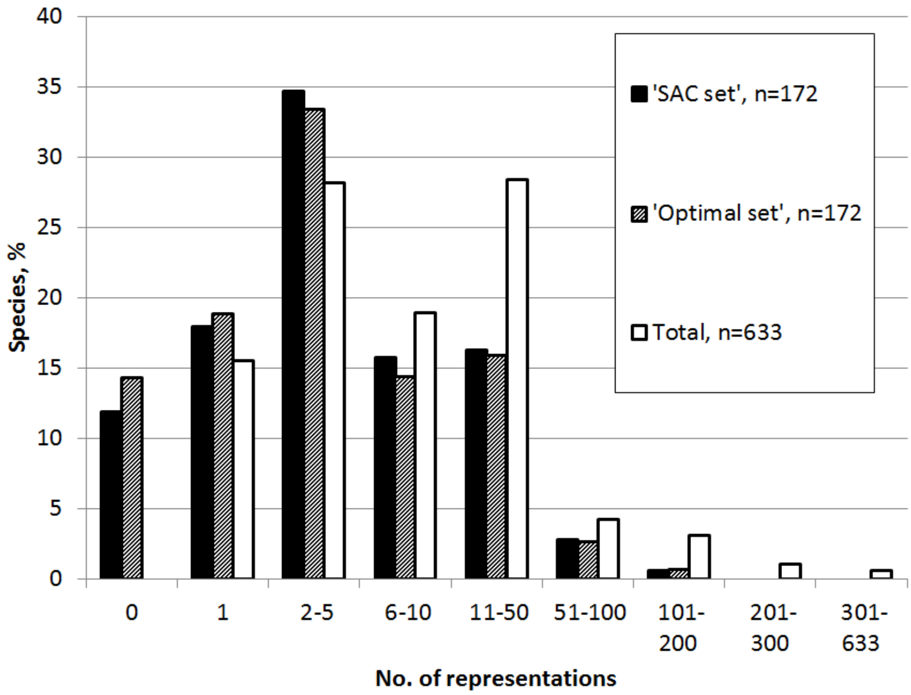

Fig. 4. Efficiency of the 'SAC set' and the 'Optimal set' in representing threatened species (n=1344) in 172 grid cells compared to the total number of representations per species in all 633 grid cells. Intervals are chosen to match the ones used by Lund (2002).

Taxon group coverage at grid cell scale

The 'SAC set' covered 27% of the 633 Danish grid cells, while its species coverage (proportion of occupied grid cells covered for each species) varied for Annex II species from 39% (amphibians) to 70% (butterflies), and for globally threatened species from 0% (birds) to 83% (other invertebrates) (Table 2). Other species groups varied in coverage from 31% (nationally threatened mammals) to 60% (nationally threatened other invertebrates). The coverage of globally threatened species was higher than 40% for all taxon groups and species, except for one fungus and the single bird both having a coverage of 0 % (Table A3, supplementary material). For the vertebrate groups and mosses no significant difference could be found compared to the null-hypothesis of random coverage (27%), while coverage was significantly (99.9%) higher for all other taxon groups and for the total species pool (Table 2). Globally threatened species did not differ significantly in coverage from Annex II species, while nationally threatened and non-annex II species had significantly lower coverage than these, but still significantly higher than the random level of 27% (Table 2).

Table 2. Grid-cell-scale coverage % of threatened species in 172 grid cells of the 'SAC set'. Average (minimum - maximum) percentage of occupied grid cells covered for each species group. The 172 grid cells cover 27% of Denmark. They are based on 163 non-marine SACs.

Threat level[1]	Annex II		Global		Non-annex II		National		Total
	X % (min - max)	n	X % (min-max)	n	X % (min-max)	n	X % (min-max)	n	N
Mammals	44.7 (27 - 67)	7		0	42.3 (22 - 67)	16	30.7 (28 - 33)	2	25
Birds		0	0 (0 - 0)	1	37.1 (0 - 100)	52	39.8 (17 - 63)	21	74
Reptiles		0		0	35.4 (35 - 35)	1		0	1
Amphibians	39.4 (33 - 46)	2		0	31.0 (24 - 34)	9		0	11
Butterflies [a]	70.0 (40 - 100)	2		0		0	47.2 (0 - 100)	30	32
Other insects [a]	66.4 (29 - 100)	5	62.0 (41 - 79)	3	31.6 (31 - 32)	2	43.0 (0 - 100)	327	337
Other invertebrates[a]	61.5 (49 - 73)	4	83.3 (83 - 83)	1	58.8 (32 - 86)	2	60.1 (17 - 100)	17	24
Fungi [a]		0	35.4 (0 - 58)	3		0	51.8 (0 - 100)	510	513
Lichens [a]		0		0	36.5 (0 - 50)	7	51.0 (0 - 100)	190	197
Mosses	54.5 (54 - 55)	2		0	47.2 (0 - 75)	33		0	35
Vascular plants [a]	66.9 (50 - 94)	5		0	31.6 (0 - 45)	7	49.0 (0 - 100)	110	122
Average [a]	57.6 (27 - 100)[b]	27	45.2 (0 - 83) [b]	8	39.1 (0 - 100) [b]	129	46.6 (0 - 100) [b]	1207	1371

[1] Species threatened at more than one geographical level are only included once (in the leftmost column it would occur). Annex II refers to the EU Habitats Directive Annex II while Non-annex II refers to other annexes of that directive plus Annex I of the EU Birds Directive. "Other invertebrates" include spiders (n=17), snails (n=4), leeches (n=1), moss scorpions (n=1) and crustaceans (n=1).

[a] For these taxon groups (excluding Annex II which was the basis for SAC designation) the mean coverage differed significantly (99.9%) from the 27% 'SAC set' coverage of Denmark. For other groups the difference was non-significant.

[b] The Annex II group differed significantly from Global (99%), Non-annex II (99%) and National (95%). Covariate slopes in the linear model were significantly (95%) different from Annex II except for group National. For Global group the slope was positive while the slope was negative for the other groups.

The linear model fitted to the coverage by SACs of each taxon group showed that the overall covariate (amount of occupied grid cells at national level for each species) was significant (95%) with a negative slope, i.e. rare species had significantly higher coverage by the 'SAC set' than less rare species. Globally threatened and non-annex II species had significantly different slopes of their covariate compared to Annex II species. For globally threatened species the slope was positive instead of the expected negative (Table 2) because some of the rarest species were not covered.

Polygon-based compared to grid cell based results

The coverage computed using detailed SAC polygon data instead of grid cells (Table 3) showed larger variation around a higher average coverage of 42% (EU non-annex II species) to 64% (globally threatened species). The coverage for all taxon groups was significantly (99.9%) higher than the null-hypothesis supposing species coverage to equal the percentage of Denmark covered by SACs (8.6%). The globally threatened species did not differ significantly in coverage from Annex II species, while nationally threatened and non-annex II species had significantly lower coverage, but still significantly (99.9%) higher than 8.6% (Table 3).

Table 3. Polygon-scale coverage % of threatened species in non-marine Danish SAC polygons. Average (minimum - maximum) percentage of all presence records 1991-2015 being inside the SAC polygons which cover 8.6% of Denmark. See table 2 for other explanations.

Threat level	Annex II		Global		Non-annex II		National		Total
	X % (min-max)	n	X % (min-max)	n	X % (min-max)	n	X % (min-max)	n	N
Mammals	49.2 (6 - 83)	7		0	24.8 (9 - 44)	16	15.9 (0 - 32)	2	25
Birds [a]		0	80.0 (80 - 80)	1	55.5 (0 - 100)	52	48.9 (0 - 100)	21	74
Reptiles		0		0	45.5 (46 - 46)	1		0	1
Amphibians	44.2 (17 - 71)	2		0	31.4 (6 - 63)	9		0	11
Butterflies [a]	79.1 (58 - 100)	2		0		0	41.3 (0 - 100)	30	32
Other insects [a]	55.6 (37 - 86)	5	51.5 (35 - 69)	3	16.2 (6 - 26)	2	39.8 (0 - 100)	327	337
Other invertebrate [a]	53.8 (33 - 66)	4	94.9 (95 - 95)	1	50.5 (13 - 88)	2	56.8 (0 - 100)	17	24
Fungi [a]		0	28.7 (0 - 43)	3		0	47.0 (0 - 100)	510	513
Lichens [a]		0		0	45.7 (20 - 78)	7	59.5 (0 - 100)	190	197
Mosses [a]	78.7 (75 - 83)	2		0	57.1 (0 - 100)	33		0	35
Vascular plants [a]	82.3 (66 - 97)	5		0	47.2 (28 - 69)	7	60.0 (0 - 100)	110	122
Average [a]	63.3 (6 - 100)[b]	27	63.8 (0 - 95)[b]	8	41.5 (0 - 100)[b]	129	46.2 (0 - 100)[b]	1207	1371

[a] For these taxon groups (excluding Annex II which was the basis for SAC designation) the mean coverage differed significantly (99.9%) from the 8.6% SAC coverage of Denmark. When the three non-significant groups were pooled into "other vertebrates" that group also became significant.

[b] The total Annex II and Global groups did not differ significantly, while Non-annex II (99%) and National (95%) were significantly different from Annex II.

Also for the polygon-based data, the linear model showed the overall covariate (amount of occupied grid cells at national level for each species) to be significant (95%) with a negative slope, i.e. rare species had significantly higher coverage by SAC polygons than less rare species. But in contrast to the grid-cell-based data, the different taxon groups and threat groups did not differ in this respect as the slopes of the covariate were not significantly different (Table 3).

Polygon-scale gap species at 0% coverage comprised 156 species (11.4%), of which only 77 species overlapped with the 160 gap species identified at grid-cell-scale. Some (41.7%) of the 156 species missed by SAC polygons had occurrence instead in nationally designated protected areas of IUCN category I – IV (Table A3, supplementary material).

Discussion

Even though the target species groups showed different distribution patterns, the Annex II species performed significantly better than random in identifying areas important for other groups using complementarity, both for globally threatened species, for species threatened at the EU level and also for the long list of nationally threatened species.

Both at grid-cell- and polygon-scale the SAC analyses similarly confirmed that the area selection based on Annex II species presence has been successful in capturing occurrences of other threatened species, by showing significantly higher coverage and representation than could be expected by chance and thereby rejecting the null-hypothesis. This is in contrast to many previous studies pointing out that it is unusual to find better than random coverage by protected areas often because of e.g. economic constraints in the designation process (e.g. Beier & de Albuquerque 2015; Gaston et al. 2008; Maiorano et al. 2006, 2007; Oldfield et al. 2004; Powell et al. 2000; Rodrigues & Brooks 2007).

The two taxon groups with only twice as high coverage as the 8.6% SAC coverage of Denmark were 1) nationally threatened mammals including only European hare *Lepus europeaus* (32%, numerous with a very wide distribution, but recently declining) and black rat *Rattus rattus* (0%, only known from three industrial facilities and non-native pest) and 2) other non-annex II insects including only the moth *Proserpinus proserpina* (6%, newly colonizing species especially on railroad gravel fields) and the dragonfly *Aeschna viridis* (26%, fairly numerous with a very wide distribution). If the non-native pest and the newly immigrant (after SAC designations) species are ignored, all species groups had at least three times as high coverage as the 8.6% SAC coverage of Denmark.

Much higher coverage of species than 8.6% by SAC polygons was indeed found for both internationally and nationally threatened species, and also for taxon groups separately including the seldom tested taxon groups of fungi, lichens and miscellaneous invertebrates including spiders. With generally three to eight times higher than 'baseline' coverage this is promising and underlines that the designation of Danish SACs has been rather successful also for less well-known taxon groups and for species of global concern which were not targets. This answers the questions left unresolved by the similar SAC-based study by Lund (2002) based on more limited data. Indeed her conclusion that species listed in Annex II of the Habitats Directive perform well as indicators of other species in site selection holds true also for threatened species in general and for taxon groups she could not include, like fungi and lichens, and also for other plants than orchids.

Besides the indicator value of Annex II species, there can be several reasons why the coverage of threatened species in the SAC network is so high. Importantly, Denmark is so heavily impacted by agriculture, urban areas and infrastructure that SAC designation was more or less restricted to the c. 30% of the land with a more natural character. Hence, the random sets inevitably included an average of 70% land lacking natural habitats. However, the higher coverage of threatened species in the actual SAC set compared to the optimal set based on Annex II species suggests that the Danish designation process was of high quality targeting areas with high value for Danish nature in general, with low intrusion from economic interests.

Denmark is the EU country with the lowest area proportion covered by Natura 2000 sites, so there is reason to expect that coverage of threatened species in other EU countries could be higher than the figures documented for Denmark. In our opinion the good coverage should hold true also for other countries, assessed by the Danish coverage not being particularly high when seen in comparison with other EU countries (Sluis et al. 2016; Trochet and Schmeller 2013). At least if the countries have followed the Natura 2000 designation guidelines and made best possible use of existing data.

It should also be acknowledged that the thorough EU designation process including scientific and NGO scrutiny of proposed Natura 2000 sites at "biogeographic" seminars (Evans 2012), and including habitat types as designation reasons, can have helped to enhance the quality of the site network. On the other hand the selection of species for Annex II has been seen as biased and based on non-transparent criteria, especially in some Mediterranean countries (Cardoso 2012; Maiorano et al. 2007, 2015). The original process for selecting Annex II species is unfortunately only vaguely described (Evans 2012; Lund 2002). This might imply that even higher efficiency could be possible if indicator species or sites were selected in a more systematic way.

One representation (or five) of a species is no guarantee for long-term viability or for favorable conservation prospects (e.g. Kujala et al. 2011), so it is fortunate that more than 70% of the species had multiple representations in the 'SAC set'. Even if the overall coverage was good, 11.9% of study species were missed by the 'SAC set' grid cells while 11.4% were missed by the SAC polygons. These gap species call for supplementary conservation actions targeting specific sites where they occur. Many of the gap species have very specific habitat requirements, while others are irregular and unpredictable in their occurrence, e.g. being geographically marginal to Denmark. Fortunately 41.7% of the 156 species missed by SAC polygons occur in nationally designated protected areas (Table A3, supplementary material) similar to the results of Maiorano et al. (2015) at European Union scale.

Both the grid-scale and polygon-scale analyses were based on the same detailed occurrence data, so the differences found between grid- versus polygon-based analyses illustrate bias introduced by fitting polygons into a fixed grid. Most Danish terrestrial SACs are smaller than a grid cell but may still intersect several grid cells. Only one grid cell was selected for each SAC except where more grid cells were necessary to represent the Annex II species used for designation of the SAC. In this process parts of SACs in other grid cells were left out, while species from large non-SAC areas surrounding the SAC entered the 'SAC set'. The bias shows up clearly in the large turnover of gap species, with only 77 of the 156 'real' (polygon-based) gap species being among the total of 160 gap species produced at grid-scale, meaning that more than half of the grid-scale gap species were in reality an artefact of the coarse grid-scale method. This is relevant e.g. for the globally threatened bird *Podiceps auritus*.

The bias from using coarse data also results in less statistical significance in the grid-based analysis, and in poorer fit of the linear models, including positive slope of the covariate in some cases. A negative slope reflecting rare species having higher coverage than less rare species is the expected result and was found for all polygon-based models, but not for all grid-cell-based models.

Sluis et al. (2016) analyzed the performance of Natura 2000 at the EU scale based on modelled and coarse distribution maps, and found much lower coverage figures for Denmark than in our study (e.g. for reptiles & amphibians their coverage was 10% against ours at 30-45%; mammals 10% against 15-50%; butterflies 25% against 40-80%; birds 15% against 48-80%). There are several possible explanations for this considerable difference. First of all Sluis et al. (2016) included common species besides threatened ones, which may lower figures, and they acknowledged limitations of their modelling method. But still the differences are dramatic and could be caused, to a large extent, by the use of too coarse species data. On the other hand most countries and regions do not have access to such detailed occurrence data as used in our study, so using coarse maps and treating resulting estimates conservatively as minimum coverage estimates would still be relevant.

Also Trochet & Schmeller (2013) in their study of Natura 2000 coverage of globally threatened species used coarse data (IUCN distribution maps for 145 species & 10 x 10 km grid cells for 155 others). They reported Natura 2000 area coverage of 11% in Denmark for globally threatened species – very different from the 76% SAC coverage of presence records that comes out of our study for the same three species which are all also on Annex II (*Dytiscus latissimus, Graphoderus bilineatus & Margaritifera margaritifera*). The main reason for the discrepancy seems to be that Trochet & Schmeller (2013) computed their coverage as if each species was present everywhere inside the used distribution maps. This is not the case in general and certainly not for the three study species, which have a very patchy occurrence in specific small habitats. Even if a Natura 2000 site is designated to include the full potential habitat of a species, it will in many cases only cover a small percentage of the grid cell or region when the actual habitat is small, which is particularly often the case for threatened species. Several authors have warned against these kinds of scale problems (e.g. Alagador et al. 2011; Araujo 2004; Battisti & Fanelli 2015), even if it is also relevant to emphasize the need to increase the area of suitable habitat for threatened species to halt biodiversity loss.

Regardless of the huge effort used in our quality control, there will inevitably also be biases of several sorts in the data used for our study, e.g. SACs may have been surveyed more intensively than other areas, "false-presences" caused by mis-identification, "false-absences" caused by overlooked species, besides other error types (Geldmann et al. 2016).

For conservation purposes it is comforting, that the SACs cover 88% of other threatened species, and not just the EU Annex II species used for designation. The Natura 2000 network in Denmark is in the second round of implementation of 6-year management plans designed to ensure that SPAs and SACs are managed properly to reach favorable conservation status as soon as possible (Anon. 2016a; Larsen & Lentz 2016). Given the high efficiency of Annex II species in representing other threatened species at 10 x 10 km and SAC scale, it seems reasonable to assume that there is also a significant overlap in habitat requirements at local scale and in relation to management requirements. If so, many other threatened species should benefit from conservation actions targeted at habitats and Annex II species in each SAC, but this needs to be investigated further by analyzing relevant ecological traits across species groups. In addition more work and protection is needed if the 12% gap species shall be covered. Some of the populations in the matrix landscape between protected areas or in nationally protected sites can perhaps be viable (Watts et al. 2009), but this needs further testing. Also global change dynamics in species occurrence are necessary to take into account if future viability is to be secured (e.g. Kujala et al. 2011).

For successful conservation of biodiversity it is essential that the management of protected sites is implemented with sufficient resources to ensure long-term viability of the species (e.g. Kati et al. 2015). The Danish Natura 2000 network has been criticized for not including sufficient areas of forest (Petersen et al. 2016). It is the aim of the Danish government to address these issues by continuing and enhancing the already ongoing work in the Natura 2000 network with an annual management budget of 40 million Euro from 2016 to 2021 increasing the active conservation management from 60 000 to 90 000 hectares of habitats (Larsen & Lentz 2016), and by designating more than 13 000 hectares of new forest reserves (Anon. 2016a; Naturstyrelsen 2018). The new reserves will be targeted at species and sites identified by this and other studies to find the most relevant and cost-efficient sites to include.

Conclusion

The EU site designation process defined in the Habitats Directive using occurrence of a multi-taxon set of indicator species combined with presence of characteristic or threatened habitats has resulted in the protected areas having a significantly higher representation and coverage of non-target threatened species than expected and previously reported. The studied site network covers only 8.6% of Denmark but on average 42 - 64% of all known occurrences of both globally and nationally threatened species. These figures even include less well-known taxonomic groups like fungi, lichens, mosses and miscellaneous invertebrates including spiders.

These results support previous studies which have concluded that site selection using multi-taxon sets of species as proxies for threatened biodiversity is efficient. This applies even though the selection process of Annex II indicator species has been criticized as being biased and based on non-transparent criteria. Enlargements of protected area networks on other continents could thus be made more efficient by using a similar designation approach as the one used for developing the European Natura 2000 network.

Acknowledgements

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Appendix A. Supplementary material in the online version.

Table A1 with overview and references for data sources.

Table A2 GBIF records.

Table A3 with details on all 1371 species included in the study.

References

Anonymous, 2015. Fuglekalenderen. [Bird calendar, in Danish], Accessed December 17th 2015 at http://dofbasen.dk/atlas/guides/Generelt/Fuglekalenderen%20til%20Atlas%20III%202014-2017.pdf .

Anonymous, 2016a. Aftale om Naturpakke. [Agreement on Nature Package, in Danish], May 2016. Ministry of Environment and Food of Denmark. 19 pp. http://mfvm.dk/fileadmin/user_upload/Natturpakke-2016.pdf

Anonymous, 2016b. Denmark's Report for the State of the World's Biodiversity for Food and Agriculture. Ministry of Environment and Food of Denmark, The Danish Agrifish Agency. 44 pp. http://lbst.dk/fileadmin/user_upload/NaturErhverv/Filer/Landbrug/Genetiske_ressourcer/Denmark_SoWBFA_FINAL.pdf

Alagador, D., Martins, M.J., Cerdeira, J.O., Cabeza, M. & Araujo, M.B., 2011. A probability-based approach to match species with reserves when data are at different resolutions. Biological Conservation 144:811-820.

Araujo, M.B., 2004. Matching species with reserves – uncertainties from using data at different resolutions. Biological Conservation 118:533-538.

Battisti, C. & Fanelli, G., 2015. Don't think local! Scale in conservation, parochialism, dogmatic bureaucracy and the implementing of the European Directives. Journal for Nature Conservation 24:24-30.

Beier, P. & de Albuquerque, F.S., 2015. Environmental diversity as a surrogate for species representation. Conserv. Biol. DOI: 10.1111/cobi.12495

Buchwald, E., 2018. Threatened species occurrences, Denmark 1991-2015. GBIF-dataset at https://doi.org/10.15468/5cpovj

Cardoso, P., 2012. Habitats Directive species lists: urgent need of revision. Insect Conservation and Diversity 5:169–174.

CBD, 2014. Global Biodiversity Outlook 4: A Mid-term Assessment of Progress Towards the Implementation of the Strategic Plan for Biodiversity 2011–2020. Montreal, Canada. Secretariat of the Convention on Biological Diversity. https://www.cbd.int/gbo/gbo4/publication/gbo4-en-hr.pdf.

DANBIF, 2016. Species checklist Denmark, DanBIF - Danish Biodiversity Information Facility, University of Copenhagen, www.allearter.dk (accessed February 1st 2016)

Dudley, N. (Editor), 2008. Guidelines for Applying Protected Area Management Categories. Gland, Switzerland. IUCN. 86pp.

Dybbro,T., 1976. De danske ynglefugles udbredelse. [Bird Atlas I, in Danish] DOF. 293 pp.

EEA, 2015. The European Environment – State and Outlook 2015: Synthesis Report. European Environment Agency, Copenhagen. Luxembourg: Publications Office of the European Union.

EEA, 2016. Natura 2000 data - the European network of protected sites. http://www.eea.europa.eu/data-and-maps/data/natura-7 permalink: 0cb5db55a14548e28344f867bc2d25c9.

Evans D., 2012. Building the European Union's Natura 2000 network. Nature Conservation 1: 11–26. doi:10.3897/natureconservation.1.1808 .

Gaston, K.J., Jackson, S.F., Nagy, A., Cantu-Salazar, L. & Johnson, M., 2008. Protected Areas in Europe. Principle and Practice. Ann.N.Y. Acad. Sci. 1134:97-119.

Geldmann, J., Heilmann-Clausen, J., Holm, T.E., Levinsky, I., Markussen, B., Olsen, K., Rahbek, C. & Tøttrup, A.P., 2016. What determines spatial bias in citizen science? Exploring four recording schemes with different proficiency requirements. Diversity and Distributions 22:1139–1149. DOI: 10.1111/ddi.12477.

Grell, M.B., 1998. Fuglenes Danmark. [Breeding Bird Atlas II, in Danish] GAD. 825 pp.

IUCN, 2015. The IUCN Red List of Threatened Species. Denmark search May 2015, permalink: http://www.iucnredlist.org/search/link/554c4d07-c8f7a9d9

Kati,V., Hovardas, T., Dieterich, M., Ibisch, P.L., Mihok, B. & Selva, N., 2015. The challenge of implementing the European network of protected areas Natura 2000. Conserv. Biol. 29:260-70.

Kujala, H., Araújo, M. B., Thuiller, W., & Cabeza, M., 2011. Misleading results from conventional gap analysis–Messages from the warming north. Biological Conservation, 144:2450-2458.

Larsen, E.L., & Lentz, C. B., 2016. What is the economy in the Natura 2000 plans for 2016-2021? [in Danish] Miljø- og Fødevareudvalget 2015-16, MOF Alm. del endeligt svar på spørgsmål 810, http://www.ft.dk/samling/20151/almdel/mof/spm/810/svar/1320835/1627535/index.htm .

Lund, M.P., 2002. Performance of the species listed in the European Community 'Habitats' Directive as indicators of species richness in Denmark. Environmental Science & Policy 5:105-112.

Lund, M.P. & Rahbek, C., 2002. Cross-taxon congruence in complementarity and conservation of temperate biodiversity. Animal Conservation 5:163-171.

Maiorano, L., Falcucci, A., & Boitani, L., 2006. Gap analysis of terrestrial vertebrates in Italy: priorities for conservation planning in a human dominated landscape. Biological Conservation, 133:455-473.

Maiorano, L., Falcucci, A., Garton, E.O. & Boitani, L., 2007. Contribution of the Natura 2000 network to biodiversity conservation in Italy. Conserv. Biol. 21:1433-44.

Maiorano, L., Amori, G., Montemaggiori, A., Rondinini, C., Santini, L., Saura, S. & Boitani, L., 2015. On how much biodiversity is covered in Europe by national protected areas and by the Natura 2000 network: insights from terrestrial vertebrates. Conserv. Biol. 29:986-95.

Naturstyrelsen, 2018. Designation of forest for biodiversity (in Danish: Udpegning af skov til biodiversitetsformål). 38 pp. http://naturstyrelsen.dk/media/230273/udpegning-af-skov-til-biodiversitetsformaal.pdf (accessed 22nd January 2018).

Oldfield, T. E., Smith, R. J., Harrop, S. R., & Leader-Williams, N., 2004. A gap analysis of terrestrial protected areas in England and its implications for conservation policy. Biological Conservation, 120:303-309.

Petersen, A.H., Strange, N., Anthon, S., Bjørner, T.B. & C. Rahbek, 2016. Conserving what, where and why? Cost-efficient measures to conserve biodiversity in Denmark. Journ. f. Nature Conservation 29:33-44.

Powell, G. V., Barborak, J., & Rodriguez, M., 2000. Assessing representativeness of protected natural areas in Costa Rica for conserving biodiversity: a preliminary gap analysis. Biological Conservation, 93:35-41.

R Core Team, 2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Rodrigues, A.S.L. & Brooks, T.M., 2007. Shortcuts for biodiversity planning; The effectiveness of surrogates. Annual Review of Ecology, Evolution, and Systematics 38:713-737.

Rudfeld, Lars, pers.comm. Information about the designation process of SACs in Denmark. Danish representative in the EU Habitats Committee. Danish Nature Agency.

Scott, J., Davis, F., Csuti, B., Noss, R., Butterfield, B., Groves, C., Anderson, H., Caicco, S., D'Erchia, F., Edwards, Jr.,T.C., Ulliman, J. and Wright, R., 1993. Gap Analysis: A Geographic Approach to Protection of Biological Diversity. Wildlife Monographs, (123), 3-41.

van der Sluis, T., Foppen, R., Gillings, S., Groen, T., Henkens, R., Hennekens, S., Huskens, K., Noble, D., Ottburg, F., Santini, L., Sierdsema, H., van Kleunen, A., Schaminee, J., van Swaay, C., Toxopeus, B., de Vries, M.W., & Jones-Walters, L., 2016. How much Biodiversity is in Natura 2000? The

"Umbrella Effect" of the European Natura 2000 protected area network. Alterra report 2730B, Wageningen, The Netherlands.

Tittensor, D. P., M. Walpole, S. L. L. Hill, D. G. Boyce, G. L. Britten, N. D. Burgess, S. H. M. Butchart, et al., 2014. A mid-term Analysis of Progress toward International Biodiversity Targets. Science 346 (6206): 241–244. doi:10.1126/science.1257484.

Trochet A., Schmeller D.S., 2013. Effectiveness of the Natura 2000 network to cover threatened species. Nature Conservation 4:35-53.

Watts, M. E., Ball, I. R., Stewart, R. S., Klein, C. J., Wilson, K., Steinback, C., Lourival, R., Kircher, L. & Possingham, H. P., 2009. Marxan with Zones: software for optimal conservation based land-and sea-use zoning. Environmental Modelling & Software, 24:1513-1521.

Wickham, H., 2009. ggplot2: elegant graphics for data analysis. Springer New York.

Williams, P.H., 1999. WORLDMAP iv WINDOWS: Software and help document 4.1. Privately distributed and from http://www.nhm.ac.uk/science/projects/worldmap, London.Version 4.20.15 (26.VIII.2001).

Wind, P. & Pihl, S. (eds.), 2010. The Danish Red List. The National Environmental Research Institute, Aarhus University. redlist.dmu.dk (updated April 2010).

Appendix A, supplementary electronic materials

Table A1 Overview of data sources and records. Used records include only study species and the years 1991-2015.

	Records			
Data provider	**Total**	**Used**	**Access date**	**Reference**
Atlas- & observation-database (Birdlife Denmark, DOFbasen)	17 961 625	110 506	17/12 2015	http://dofbasen.dk/
Birds & Nature web-database (license B05/2014, Fugle & Natur)	1 958 677	57 402	2/12 2015	http://www.fugleognatur.dk/
Bugbase (Lepidopterological Society, Denmark)	859 969	23 689	21/12 2015	http://www.bugbase.dk/
Biodiversity map, HNV-forest update (Danish Nature Agency)	54 997	22 764	2/5 2016	Johannsen, V. K., 2015 & digital data 2/5 2016
Biodiversity map, 2014 (Danish Nature Agency)	23 185	20 919	9/12 2015	Ejrnæs et al., 2014 & digital update
Danish fungal records database (Danish Mycological Society)	559 159	19 868	17/11 2015	http://www.svampeatlas.dk/
An Annotated Atlas of the Danish Butterflies (Zoological Museum)	199 307	5288	15/1 2014	Stoltze, M., 1994
"Forests of special nature value § 25" (Danish Nature Agency)	49 894	2401	1/12 2015	Naturstyrelsen 2007
Danish Nature Agency database on things to protect, "Pas-paa-kort"	8526	1867	3/11 2015	Naturstyrelsen 2015
Atlas Flora Danica data 1992-2013, red list & forest extract (Danish Botanical Society)	123 334	1460	22/4 2014	Hartvig, P., 2015
Entomological Society of Fünen database (Fynske insekter)	167 905	971	20/1 2016	http://www.fynskeinsekter.dk/
Spiders of Denmark online database	31 731	158	3/11 2015	http://www.danmarks-edderkopper.dk/
Epiphytic lichens and bryophytes in the forests of Lille Vildmose in 2013	210	81	19/4 2016	Fritz, Ô., 2014
Roof-top insect study 1992-2009 (Zoological Museum)	44 088	57	14/1 2016	Thomsen et al., 2015
Digital databases of invertebrates (Natural History Museum of Denmark)	69 436	35	1/12 2015	Stein, M., 2015
Epiphytic lichens in the forest of Kås in 2002	85	29	19/4 2016	Larsen, R.S., 2002
Epiphytic lichens and bryophytes on oak in the forest of Tofte 2012-2013	104	28	19/4 2016	Mouridsen, M.T., 2014
Status books on the forests of Tofte & Høstemark	3331	11	19/4 2016	Hald-Mortensen, P., 2012 & 2002
Danish Topographical Botanical Survey online, "TBU collections"	3299	5	21/12 2015	http://www.daim.snm.ku.dk/TBU-en
Hepatics at the Herbarium C. (Natural History Museum of Denmark)	9306	0	3/11 2015	http://www.daim.snm.ku.dk/hepatics
Total	22 128 168	267 064	Total	

References for table A1:

Ejrnæs et al., 2014. *Biodiversitetskort for Danmark*. Rapp 112/2014, DCE.

Fritz, Ô. 2014. *Epiphytic lichens and bryophytes in the forests of Lille Vildmose in 2013*. Naturcentrum report 2014-03-04, 34 pp.

Hald-Mortensen, P. 2012. *Tofte Skov og Mose - status 2012*. AVJF, 387 pp.

Hartvig, P., 2015. *Atlas Flora Danica*. 3 volumes. Gyldendal, København.

Johannsen, V. K., 2015. *Udvikling af et High Nature Value - HNV-skovkort for Danmark*. IGN rapport, nov 2015.

Larsen, R.S., 2002. *Biodiversitet, kvistflora og kvælstofbelastning. Kås Skov, 2002*. KU speciale rapport.

Mouridsen, M.T., 2014. *Epifytiske laver og mosser på eg i Tofte Skov. Status 2012-13*. Specialerapport, KU Biol. Inst. 2014.

Naturstyrelsen, 2007. *Data from 2007 COWI project "Forests of special nature value § 25"*. Unpublished.

Naturstyrelsen, 2015. *Database on things to protect, "Pas-paa-kort", Naturreg*. Unpublished.

Naturstyrelsen, 2016. *Digital biodiversity map 2016*, updatet ArcGis files March 18th 2016. Unpublished.

Stein. M., in litt. 2015. *RE: Forespørgsel på invertebratdata til mit PhD*. Email 1/12 2015 from SNHM.

Stoltze, M., 1994. *An Annotated Atlas of the Danish Butterflies*. Zoological Museum, 134 pp.

Thomsen, P. F., Jørgensen, P. S., Bruun, H. H., Pedersen, J., Riis-Nielsen, T., Jonko, K., Słowińska, I., Rahbek, C., Karsholt, O., 2015. *Resource specialists lead local insect community turnover associated with temperature – analysis of an 18-year full-seasonal record of moths and beetles*. Journal of Animal Ecology. doi: 10.1111/1365-2656.12452.

Table A2 Overview of GBIF records for Denmark September 2016

GBIF records for DK	**Records**	**Percent**
Redundant to data in table A1 (updated original data used instead)	8 917 771	87
Coordinate projection uncertain (and probably also redundant)	606 352	6
With other "known coordinate issues" (and probably also redundant)	490 677	5
No study species	117 289	1
No years	113 546	1
Total GBIF records for Denmark (5/9 2016)	10 245 635	100

Reference: GBIF 2016. GBIF.org (5th September 2016) *GBIF Occurrence Download* http://doi.org/10.15468/dl.obr3f0

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
annex II	Mammal	Barbastella barbastellus	335	5.7	6.0	23.9	29	14
annex II	Mammal	Canis lupus	6	33.3	83.3	83.3	3	2
annex II	Mammal	Halichoerus grypus	1519	24.2	68.7	70.6	126	50
annex II	Mammal	Lutra lutra	14355	3.1	21.5	60.1	421	112
annex II	Mammal	Myotis bechsteinii	6	0.0	66.7	83.3	2	1
annex II	Mammal	Myotis dasycneme	41	4.9	29.3	34.2	10	5
annex II	Mammal	Phoca vitulina	10595	12.3	69.2	73.5	298	95
annex II	Amphibian	Bombina bombina	1082	0.0	71.0	94.4	26	12
annex II	Amphibian	Triturus cristatus	4950	2.6	17.3	78.3	405	132
annex II	Butterfly	Euphydryas aurinia	993	0.5	58.4	82.4	30	12
annex II	Butterfly	Maculinea arion	497	91.0	99.8	99.8	5	5
annex II	Other insect	Leucorrhinia pectoralis	596	0.5	56.0	77.0	21	12
annex II	Other insect	Ophiogomphus cecilia	381	3.4	37.3	54.3	72	21
annex II	Other insect	Osmoderma eremita	145	16.6	55.9	75.2	12	10
annex II	Other invertebrate	Anthrenochernes stellae	12	8.3	33.3	50.0	9	6
annex II	Other invertebrate	Vertigo angustior	244	4.9	66.4	92.2	75	43
annex II	Other invertebrate	Vertigo geyeri	44	0.0	56.8	88.6	15	11
annex II	Moss	Buxbaumia viridis	255	17.7	82.8	85.9	13	7
annex II	Moss	Hamatocaulis vernicosus	188	0.5	74.5	96.3	29	16
annex II	Plant	Botrychium simplex	111	0.0	97.3	100.0	4	2
annex II	Plant	Cypripedium calceolus	138	20.3	68.8	69.6	3	2
annex II	Plant	Liparis loeselii	1360	0.0	91.5	98.1	18	17
annex II	Plant	Luronium natans	65	0.0	66.2	78.5	10	5
annex II	Plant	Saxifraga hirculus	149	0.0	87.9	99.3	15	11
annex II & globa	Other insect	Dytiscus latissimus	63	0.0	42.9	47.6	8	5
annex II & globa	Other insect	Graphoderus bilineatus	49	0.0	85.7	98.0	6	6
annex II & globa	Other invertebrate	Vertigo moulinsiana	361	9.4	58.7	94.7	88	43
global	Bird	Podiceps auritus	5	0.0	80.0	100.0	2	0
global	Other insect	Ampedus hjorti	65	9.2	50.8	63.1	21	14
global	Other insect	Formicoxenus nitidulus	26	3.9	69.2	76.9	14	11
global	Other insect	Phyllodesma ilicifolia	231	20.4	34.6	64.5	32	13
global	Other invertebrate	Dolomedes plantarius	39	7.7	94.9	94.9	6	5
global	Fungi	Hygrocybe citrinovirens	67	3.0	43.3	77.6	19	11
global	Fungi	Hygrocybe ingrata	131	3.8	42.8	78.6	29	14
global	Fungi	Tricholoma acerbum	21	0.0	0.0	0.0	3	0
EU non-annex II	Mammal	Eptesicus nilssonii	23	0.0	8.7	13.0	3	2
EU non-annex II	Mammal	Eptesicus serotinus	179	5.6	21.2	34.6	93	38
EU non-annex II	Mammal	Martes martes	597	9.2	24.0	34.3	173	66
EU non-annex II	Mammal	Muscardinus avellanarius	178	0.0	21.9	24.7	18	5
EU non-annex II	Mammal	Mustela putorius	904	3.2	21.1	34.1	292	97
EU non-annex II	Mammal	Myotis brandtii	64	4.7	21.9	31.3	17	10
EU non-annex II	Mammal	Myotis daubentonii	281	4.6	32.7	53.0	95	48
EU non-annex II	Mammal	Myotis mystacinus	50	0.0	16.0	28.0	9	2
EU non-annex II	Mammal	Myotis nattereri	99	9.1	18.2	35.4	54	27
EU non-annex II	Mammal	Nyctalus noctula	804	1.7	39.4	54.6	125	53
EU non-annex II	Mammal	Pipistrellus nathusii	100	10.0	41.0	60.0	41	19
EU non-annex II	Mammal	Pipistrellus pipistrellus	13	0.0	15.4	38.5	10	5
EU non-annex II	Mammal	Pipistrellus pygmaeus	547	9.9	26.9	42.4	114	44
EU non-annex II	Mammal	Plecotus auritus	36	19.4	44.4	61.1	26	12
EU non-annex II	Mammal	Sicista betulina	60	5.0	30.0	50.0	20	5
EU non-annex II	Mammal	Vespertilio murinus	521	0.6	14.0	17.1	25	10
EU non-annex II	Bird	Aegolius funereus	98	4.1	39.8	40.8	18	6
EU non-annex II	Bird	Alcedo atthis	1140	1.9	30.4	51.2	180	66
EU non-annex II	Bird	Anthus campestris	55	34.6	72.7	98.2	6	2
EU non-annex II	Bird	Aquila chrysaetos	43	88.4	90.7	90.7	6	1
EU non-annex II	Bird	Ardea alba	4	25.0	50.0	100.0	4	2
EU non-annex II	Bird	Asio flammeus	98	3.1	36.7	89.8	26	6
EU non-annex II	Bird	Botaurus stellaris	6662	13.2	72.8	94.5	208	82
EU non-annex II	Bird	Branta leucopsis	160	0.6	48.1	78.8	28	7
EU non-annex II	Bird	Bubo bubo	448	3.1	17.9	21.2	82	22
EU non-annex II	Bird	Calidris alpina schinzii	273	0.7	91.6	96.0	45	14
EU non-annex II	Bird	Caprimulgus europaeus	2661	2.7	33.2	41.0	161	61
EU non-annex II	Bird	Charadrius alexandrinus	312	2.2	87.8	87.8	12	3
EU non-annex II	Bird	Chlidonias niger	254	0.4	74.4	94.5	14	6
EU non-annex II	Bird	Ciconia ciconia	483	0.0	1.0	19.5	14	5
EU non-annex II	Bird	Circus aeruginosus	5940	5.6	48.7	83.1	370	122
EU non-annex II	Bird	Circus cyaneus	58	1.7	91.4	96.6	12	4
EU non-annex II	Bird	Circus pygargus	774	0.8	23.3	57.6	42	10
EU non-annex II	Bird	Coracias garrulus	1	0.0	0.0	0.0	1	0

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
EU non-annex II	Bird	Crex crex	3437	0.6	17.8	43.7	291	89
EU non-annex II	Bird	Cygnus cygnus	183	3.8	10.9	66.7	18	6
EU non-annex II	Bird	Dendrocopos medius	1	0.0	0.0	0.0	1	0
EU non-annex II	Bird	Dryocopus martius	2081	7.5	48.8	58.5	170	60
EU non-annex II	Bird	Falco peregrinus	733	17.5	28.4	37.1	37	17
EU non-annex II	Bird	Ficedula parva	588	17.7	43.0	55.6	75	34
EU non-annex II	Bird	Gallinago media	87	2.3	98.9	98.9	13	9
EU non-annex II	Bird	Gelochelidon nilotica	163	0.6	44.8	78.5	13	2
EU non-annex II	Bird	Grus grus	2948	15.6	70.7	86.3	182	62
EU non-annex II	Bird	Haliaeetus albicilla	1467	21.2	62.7	75.9	153	58
EU non-annex II	Bird	Himantopus himantopus	149	45.0	47.7	49.7	6	2
EU non-annex II	Bird	Hydrocoloeus minutus	49	0.0	100.0	100.0	1	1
EU non-annex II	Bird	Hydroprogne caspia	30	3.3	80.0	96.7	10	2
EU non-annex II	Bird	Lanius collurio	5972	6.6	49.4	62.9	433	138
EU non-annex II	Bird	Larus melanocephalus	898	0.0	12.4	88.4	42	18
EU non-annex II	Bird	Lullula arborea	3498	4.6	34.8	45.4	246	85
EU non-annex II	Bird	Luscinia svecica	2643	4.2	51.8	87.6	123	41
EU non-annex II	Bird	Milvus milvus	889	1.4	7.3	16.3	189	55
EU non-annex II	Bird	Pandion haliaetus	35	25.7	80.0	85.7	9	6
EU non-annex II	Bird	Pernis apivorus	1233	9.9	40.6	55.2	223	76
EU non-annex II	Bird	Philomachus pugnax	265	1.1	72.5	90.6	46	19
EU non-annex II	Bird	Platalea leucorodia	94	0.0	88.3	98.9	19	7
EU non-annex II	Bird	Pluvialis apricaria	86	5.8	75.6	93.0	18	11
EU non-annex II	Bird	Porzana parva	93	0.0	100.0	100.0	3	3
EU non-annex II	Bird	Porzana porzana	1652	17.9	65.1	86.8	171	65
EU non-annex II	Bird	Porzana pusilla	211	60.7	97.6	98.6	6	4
EU non-annex II	Bird	Recurvirostra avosetta	3554	2.2	70.1	85.2	179	64
EU non-annex II	Bird	Sterna hirundo	1121	0.6	54.2	84.6	135	51
EU non-annex II	Bird	Sterna paradisaea	1804	0.9	73.5	80.9	163	53
EU non-annex II	Bird	Sterna sandvicensis	468	0.2	51.1	87.8	90	28
EU non-annex II	Bird	Sternula albifrons	1189	3.4	74.4	80.3	116	43
EU non-annex II	Bird	Sylvia nisoria	21	14.3	71.4	90.5	8	5
EU non-annex II	Bird	Tetrao tetrix	6	0.0	83.3	83.3	1	0
EU non-annex II	Bird	Tringa glareola	248	6.9	70.6	80.7	36	11
EU non-annex II	Reptile	Lacerta agilis	2389	11.6	45.5	69.8	311	110
EU non-annex II	Amphibian	Bufotes variabilis	1029	0.4	50.3	78.0	112	38
EU non-annex II	Amphibian	Epidalea calamita	1442	14.2	63.4	82.4	199	64
EU non-annex II	Amphibian	Hyla arborea	4658	0.2	5.8	61.8	104	25
EU non-annex II	Amphibian	Pelobates fuscus	1076	1.0	9.8	87.6	134	37
EU non-annex II	Amphibian	Pelophylax esculentus	3972	3.4	37.4	64.1	205	70
EU non-annex II	Amphibian	Pelophylax ridibundus	36	0.0	47.2	61.1	9	3
EU non-annex II	Amphibian	Rana arvalis	5533	4.9	27.1	89.8	430	141
EU non-annex II	Amphibian	Rana dalmatina	2250	3.7	19.4	74.3	143	42
EU non-annex II	Amphibian	Rana temporaria	3030	4.3	22.2	52.1	375	117
EU non-annex II	Other insect	Aeshna viridis	849	0.8	26.4	65.0	74	24
EU non-annex II	Other insect	Proserpinus proserpina	68	1.5	5.9	11.8	13	4
EU non-annex II	Other invertebrate	Helix pomatia	1675	3.5	12.9	32.1	283	90
EU non-annex II	Other invertebrate	Hirudo medicinalis	42	7.1	88.1	97.6	7	6
EU non-annex II	Lichen	Cladonia arbuscula	61	13.1	41.0	67.2	42	17
EU non-annex II	Lichen	Cladonia ciliata	308	11.0	77.6	94.8	82	34
EU non-annex II	Lichen	Cladonia portentosa	368	14.4	51.9	69.6	143	50
EU non-annex II	Lichen	Cladonia pp., subgenus Cladina sp.	148	9.5	32.4	54.1	5	2
EU non-annex II	Lichen	Cladonia rangiferina	47	12.8	46.8	66.0	93	32
EU non-annex II	Lichen	Cladonia stellaris	2	0.0	50.0	100.0	2	0
EU non-annex II	Lichen	Cladonia stygia	5	0.0	20.0	100.0	2	1
EU non-annex II	Moss	Leucobryum glaucum	186	18.8	53.2	75.8	87	41
EU non-annex II	Moss	Sphagnum affine	12	0.0	8.3	83.3	7	3
EU non-annex II	Moss	Sphagnum angustifolium	147	12.9	61.2	85.0	49	24
EU non-annex II	Moss	Sphagnum auriculatum	105	13.3	64.8	86.7	42	22
EU non-annex II	Moss	Sphagnum austinii	1	100.0	100.0	100.0	1	0
EU non-annex II	Moss	Sphagnum balticum	5	20.0	80.0	100.0	3	1
EU non-annex II	Moss	Sphagnum capillifolium	55	45.5	67.3	81.8	24	12
EU non-annex II	Moss	Sphagnum centrale	20	5.0	70.0	90.0	8	6
EU non-annex II	Moss	Sphagnum compactum	23	26.1	65.2	87.0	14	6
EU non-annex II	Moss	Sphagnum contortum	44	4.6	54.6	86.4	18	11
EU non-annex II	Moss	Sphagnum cuspidatum	159	11.3	59.8	84.3	60	26
EU non-annex II	Moss	Sphagnum fallax	377	14.1	57.3	83.8	112	52
EU non-annex II	Moss	Sphagnum fimbriatum	393	12.7	53.2	84.0	133	60
EU non-annex II	Moss	Sphagnum flexuosum	35	11.4	65.7	91.4	22	13

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
EU non-annex II	Moss	Sphagnum fuscum	29	17.2	37.9	96.6	14	9
EU non-annex II	Moss	Sphagnum girgensohnii	36	25.0	52.8	77.8	25	13
EU non-annex II	Moss	Sphagnum inundatum	102	8.8	49.0	83.3	50	27
EU non-annex II	Moss	Sphagnum lindbergii	7	0.0	57.1	100.0	2	0
EU non-annex II	Moss	Sphagnum magellanicum	158	13.3	60.1	85.4	61	24
EU non-annex II	Moss	Sphagnum majus	3	0.0	0.0	100.0	3	1
EU non-annex II	Moss	Sphagnum molle	13	15.4	69.2	92.3	9	5
EU non-annex II	Moss	Sphagnum obtusum	16	0.0	75.0	81.3	8	5
EU non-annex II	Moss	Sphagnum palustre	496	11.9	56.7	83.7	134	58
EU non-annex II	Moss	Sphagnum papillosum	112	12.5	45.5	85.7	54	25
EU non-annex II	Moss	Sphagnum quinquefarium	2	0.0	50.0	50.0	2	1
EU non-annex II	Moss	Sphagnum riparium	82	9.8	59.8	87.8	27	11
EU non-annex II	Moss	Sphagnum rubellum	155	12.3	55.5	85.2	56	26
EU non-annex II	Moss	Sphagnum russowii	136	24.3	63.2	88.2	49	24
EU non-annex II	Moss	Sphagnum squarrosum	359	9.2	55.2	85.0	119	63
EU non-annex II	Moss	Sphagnum subnitens	197	5.6	60.4	89.9	89	46
EU non-annex II	Moss	Sphagnum tenellum	37	24.3	67.6	83.8	24	12
EU non-annex II	Moss	Sphagnum teres	165	7.3	55.2	87.9	67	39
EU non-annex II	Moss	Sphagnum warnstorfii	34	11.8	52.9	88.2	18	11
EU non-annex II	Plant	Arnica montana	817	3.3	28.4	72.5	156	44
EU non-annex II	Plant	Diphasiastrum complanatum	32	0.0	28.1	31.3	4	0
EU non-annex II	Plant	Diphasiastrum tristachyum	130	20.8	63.9	90.0	14	6
EU non-annex II	Plant	Huperzia selago	264	8.3	56.4	67.8	67	30
EU non-annex II	Plant	Lycopodiella inundata	270	5.2	69.3	91.1	57	19
EU non-annex II	Plant	Lycopodium annotinum	763	9.6	38.0	57.8	158	58
EU non-annex II	Plant	Lycopodium clavatum	575	9.2	46.3	60.0	131	46
DK	Mammal	Lepus europaeus	27288	4.5	31.8	53.7	602	169
DK	Mammal	Rattus rattus	4	0.0	0.0	0.0	3	1
DK	Bird	Acrocephalus arundinaceus	679	5.2	40.8	91.9	74	30
DK	Bird	Anas acuta	171	0.0	90.6	97.1	51	23
DK	Bird	Anas penelope	78	1.3	59.0	78.2	34	14
DK	Bird	Arenaria interpres	31	0.0	100.0	100.0	8	4
DK	Bird	Athene noctua	91	0.0	2.2	4.4	19	4
DK	Bird	Carpodacus erythrinus	2811	13.5	50.7	63.3	173	60
DK	Bird	Cinclus cinclus	36	0.0	36.1	58.3	13	6
DK	Bird	Falco subbuteo	172	0.0	27.3	37.8	48	17
DK	Bird	Galerida cristata	421	0.0	0.2	3.8	18	3
DK	Bird	Jynx torquilla	973	11.0	48.2	60.7	179	71
DK	Bird	Lanius excubitor	40	0.0	72.5	90.0	21	10
DK	Bird	Limosa limosa	947	0.5	73.5	95.0	57	14
DK	Bird	Locustella luscinioides	491	0.2	57.8	88.2	69	26
DK	Bird	Mergus merganser	1211	3.3	23.6	44.3	68	28
DK	Bird	Netta rufina	44	0.0	88.6	97.7	5	2
DK	Bird	Nucifraga caryocatactes	61	11.5	39.3	47.5	24	15
DK	Bird	Oriolus oriolus	771	23.9	51.2	63.0	163	67
DK	Bird	Remiz pendulinus	859	1.8	31.4	83.9	83	28
DK	Bird	Serinus serinus	861	3.1	12.5	34.6	132	54
DK	Bird	Tringa ochropus	607	4.9	59.5	76.1	71	26
DK	Bird	Upupa epops	8	0.0	62.5	62.5	5	3
DK	Butterfly	Argynnis adippe	1202	1.4	30.5	46.6	122	48
DK	Butterfly	Argynnis aglaja	1948	3.7	38.9	61.0	214	87
DK	Butterfly	Argynnis niobe	1181	8.3	41.7	60.6	146	52
DK	Butterfly	Argynnis paphia	5276	8.0	29.4	44.8	267	99
DK	Butterfly	Aricia artaxerxes	255	0.0	42.0	58.4	9	4
DK	Butterfly	Boloria aquilonaris	1459	9.7	53.1	83.9	122	47
DK	Butterfly	Boloria euphrosyne	811	0.5	32.9	43.4	51	17
DK	Butterfly	Brenthis ino	793	7.4	52.0	84.2	52	24
DK	Butterfly	Carterocephalus silvicola	324	0.0	79.9	86.4	4	4
DK	Butterfly	Coenonympha arcania	28	60.7	60.7	60.7	1	0
DK	Butterfly	Coenonympha tullia	1247	10.4	42.7	78.2	136	50
DK	Butterfly	Cyaniris semiargus	1434	5.9	29.1	49.5	238	81
DK	Butterfly	Erynnis tages	1169	5.8	48.3	76.0	84	30
DK	Butterfly	Hesperia comma	1061	16.0	55.8	81.5	88	35
DK	Butterfly	Leptidea juvernica	47	0.0	100.0	100.0	2	2
DK	Butterfly	Leptidea sinapis	23	0.0	100.0	100.0	1	1
DK	Butterfly	Lycaena hippothoe	2265	6.6	29.6	52.9	219	80
DK	Butterfly	Lycaena tityrus	478	0.0	21.3	69.5	9	5
DK	Butterfly	Maculinea alcon	742	8.0	54.5	75.3	76	30
DK	Butterfly	Melitaea athalia	1546	0.2	25.1	70.5	48	18

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Butterfly	Melitaea cinxia	4588	7.2	38.7	59.4	345	105
DK	Butterfly	Melitaea diamina	51	0.0	7.8	98.0	3	2
DK	Butterfly	Nymphalis polychloros	41	2.4	9.8	36.6	22	8
DK	Butterfly	Papilio machaon	290	9.7	27.2	39.7	99	38
DK	Butterfly	Plebejus argus	1680	6.3	44.6	72.6	178	64
DK	Butterfly	Pyrgus armoricanus	458	0.0	65.1	71.0	8	6
DK	Butterfly	Pyrgus malvae	1898	6.1	44.4	60.6	278	94
DK	Butterfly	Satyrium ilicis	4	0.0	0.0	100.0	1	1
DK	Butterfly	Satyrium w-album	1859	2.6	11.3	25.9	312	103
DK	Butterfly	Thecla betulae	1752	9.3	24.0	38.6	144	50
DK	Other insect	Abdera bifasciata	3	33.3	33.3	66.7	3	1
DK	Other insect	Acontia trabealis	230	0.9	10.9	18.3	41	10
DK	Other insect	Acronicta cinerea	711	0.3	1.4	3.9	14	5
DK	Other insect	Acronicta cuspis	117	41.0	82.1	85.5	16	4
DK	Other insect	Acronicta tridens	174	4.0	20.1	47.7	42	9
DK	Other insect	Adscita statices	1697	6.9	33.6	57.6	300	98
DK	Other insect	Aegomorphus clavipes	1	0.0	0.0	0.0	1	0
DK	Other insect	Agonum dolens	1	0.0	100.0	100.0	1	0
DK	Other insect	Agonum ericeti	12	50.0	75.0	100.0	5	2
DK	Other insect	Agriotes ustulatus	1	0.0	0.0	0.0	1	0
DK	Other insect	Agrochola nitida	129	25.6	33.3	58.9	31	17
DK	Other insect	Allandrus undulatus	2	0.0	100.0	100.0	1	1
DK	Other insect	Allecula morio	7	0.0	28.6	42.9	5	3
DK	Other insect	Allecula rhenana	6	0.0	16.7	16.7	2	1
DK	Other insect	Amara ingenua	2	50.0	100.0	100.0	2	0
DK	Other insect	Ampedus nigerrimus	16	0.0	6.3	81.3	4	1
DK	Other insect	Ampedus praeustus	11	0.0	0.0	0.0	2	1
DK	Other insect	Ampedus quercicola	18	0.0	61.1	66.7	3	3
DK	Other insect	Ampedus sanguineus	23	0.0	17.4	17.4	8	1
DK	Other insect	Amphimallon ochraceum	5	20.0	60.0	60.0	5	2
DK	Other insect	Amphipoea lucens	141	34.8	49.7	74.5	22	10
DK	Other insect	Amphipyra perflua	53	0.0	5.7	5.7	5	1
DK	Other insect	Anasimyia lunulata	51	0.0	15.7	27.5	16	8
DK	Other insect	Anaspis ruficollis	2	0.0	0.0	0.0	2	1
DK	Other insect	Aneurus avenius	11	0.0	9.1	36.4	5	3
DK	Other insect	Anthicus sellatus	4	0.0	75.0	75.0	4	2
DK	Other insect	Apamea aquila	84	11.9	79.8	86.9	5	0
DK	Other insect	Aphodius coenosus	18	16.7	72.2	88.9	10	6
DK	Other insect	Aphodius fasciatus	4	50.0	75.0	75.0	3	2
DK	Other insect	Aphodius obliteratus	1	0.0	0.0	0.0	1	0
DK	Other insect	Aphodius scrofa	2	100.0	100.0	100.0	1	1
DK	Other insect	Aphodius sordidus	1	0.0	0.0	0.0	1	0
DK	Other insect	Apion armatum	2	0.0	50.0	50.0	2	1
DK	Other insect	Apion carduorum	8	0.0	0.0	12.5	2	0
DK	Other insect	Apion simum	2	0.0	0.0	0.0	1	1
DK	Other insect	Apion sulcifrons	2	0.0	50.0	100.0	2	0
DK	Other insect	Apion vorax	7	0.0	0.0	28.6	2	0
DK	Other insect	Apteropeda orbiculata	1	0.0	100.0	100.0	1	0
DK	Other insect	Aradus betulae	87	24.1	94.3	97.7	11	7
DK	Other insect	Arctophila bombiformis	92	3.3	15.2	31.5	20	8
DK	Other insect	Arctophila superbiens	248	12.9	29.8	45.6	56	21
DK	Other insect	Asilus crabroniformis	108	5.6	40.7	58.3	53	26
DK	Other insect	Aulonium trisulcum	18	0.0	5.6	16.7	3	0
DK	Other insect	Bagous nodulosus	1	0.0	100.0	100.0	1	0
DK	Other insect	Baris lepidii	5	0.0	100.0	100.0	1	0
DK	Other insect	Bembidion bipunctatum	1	0.0	100.0	100.0	1	1
DK	Other insect	Bembidion dentellum	1	0.0	0.0	0.0	1	0
DK	Other insect	Bembidion ephippium	3	0.0	100.0	100.0	2	0
DK	Other insect	Bembidion humerale	1	0.0	0.0	100.0	1	0
DK	Other insect	Bembidion litorale	1	0.0	0.0	100.0	1	0
DK	Other insect	Bembidion lunatum	5	0.0	0.0	0.0	3	1
DK	Other insect	Bembidion maritimum	3	0.0	100.0	100.0	1	0
DK	Other insect	Blaps lethifera	15	0.0	6.7	6.7	2	0
DK	Other insect	Bombus humilis	1	0.0	100.0	100.0	1	0
DK	Other insect	Bombus veteranus	46	0.0	39.1	82.6	7	1
DK	Other insect	Brachinus crepitans	10	0.0	0.0	50.0	1	1
DK	Other insect	Brachionycha nubeculosa	7	0.0	0.0	14.3	2	1
DK	Other insect	Brachyopa bicolor	6	0.0	33.3	33.3	3	3
DK	Other insect	Brachyopa panzeri	95	0.0	6.3	24.2	17	7

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Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Other insect	Brachyopa scutellaris	27	0.0	14.8	22.2	18	6
DK	Other insect	Brachypalpus laphriformis	94	2.1	22.3	31.9	23	14
DK	Other insect	Bradybatus kellneri	1	0.0	0.0	0.0	1	1
DK	Other insect	Bryophila domestica	56	16.1	28.6	32.1	23	8
DK	Other insect	Bryophila raptricula	532	0.2	4.5	6.0	15	6
DK	Other insect	Caliprobola speciosa	38	0.0	7.9	10.5	7	3
DK	Other insect	Calliteara abietis	90	0.0	45.6	46.7	8	2
DK	Other insect	Calophasia lunula	95	15.8	13.7	21.1	12	2
DK	Other insect	Calosoma auropunctatum	1	0.0	0.0	0.0	1	0
DK	Other insect	Calosoma inquisitor	12	0.0	8.3	16.7	6	2
DK	Other insect	Carabus auratus	18	0.0	88.9	94.4	3	1
DK	Other insect	Carabus cancellatus	37	2.7	16.2	40.5	10	5
DK	Other insect	Carabus clathratus	42	11.9	61.9	88.1	21	7
DK	Other insect	Carabus glabratus	17	0.0	52.9	52.9	5	2
DK	Other insect	Carabus intricatus	19	15.8	52.6	52.6	5	5
DK	Other insect	Carabus nitens	30	10.0	83.3	83.3	14	5
DK	Other insect	Caradrina montana	4	25.0	25.0	25.0	4	1
DK	Other insect	Caryocolum fischerella	5	0.0	0.0	0.0	3	2
DK	Other insect	Cassida murraea	3	0.0	100.0	100.0	2	1
DK	Other insect	Cerambyx scopoli	28	3.6	28.6	64.3	13	9
DK	Other insect	Ceutorhynchus assimilis	7	0.0	0.0	14.3	7	4
DK	Other insect	Ceutorhynchus posthumus	1	0.0	0.0	0.0	1	1
DK	Other insect	Chalcosyrphus piger	67	4.5	9.0	25.4	16	8
DK	Other insect	Chalcosyrphus valgus	48	4.2	45.8	54.2	9	3
DK	Other insect	Chamaesyrphus lusitanicus	1	0.0	100.0	100.0	1	1
DK	Other insect	Cheilosia flavipes	9	0.0	22.2	33.3	5	3
DK	Other insect	Cheilosia frontalis	59	5.1	22.0	33.9	19	9
DK	Other insect	Cheilosia illustrata	223	2.2	4.5	23.8	33	13
DK	Other insect	Chersotis cuprea	8	0.0	0.0	0.0	1	0
DK	Other insect	Chionodes ignorantella	1	0.0	0.0	0.0	1	0
DK	Other insect	Chlaenius tristis	3	0.0	66.7	100.0	2	1
DK	Other insect	Chloantha hyperici	130	0.0	0.8	0.8	3	1
DK	Other insect	Chorthippus dorsatus	23	0.0	69.6	73.9	10	4
DK	Other insect	Chorthippus mollis	7	0.0	28.6	57.1	3	0
DK	Other insect	Chrysolina carnifex	4	0.0	100.0	100.0	1	1
DK	Other insect	Chrysolina graminis	1	0.0	0.0	0.0	1	0
DK	Other insect	Chrysotoxum verralli	3	0.0	66.7	66.7	2	1
DK	Other insect	Clostera anastomosis	20	0.0	5.0	15.0	7	1
DK	Other insect	Coeliastes lamii	1	0.0	0.0	100.0	1	0
DK	Other insect	Coenagrion armatum	62	35.5	88.7	98.4	10	6
DK	Other insect	Colydium elongatum	2	0.0	50.0	100.0	2	1
DK	Other insect	Conisania leineri	189	0.0	2.7	7.9	4	1
DK	Other insect	Copris lunaris	11	0.0	100.0	100.0	1	1
DK	Other insect	Coranarta cordigera	95	48.4	61.1	89.5	15	8
DK	Other insect	Coriomeris scabricornis	12	16.7	25.0	50.0	8	2
DK	Other insect	Coryssomerus capucinus	3	0.0	100.0	100.0	1	1
DK	Other insect	Cosmia affinis	64	1.6	12.5	21.9	24	10
DK	Other insect	Crepidophorus mutilatus	60	13.3	41.7	55.0	19	15
DK	Other insect	Criorhina floccosa	78	3.9	19.2	32.1	22	15
DK	Other insect	Cryptocephalus bilineatus	1	0.0	0.0	0.0	1	0
DK	Other insect	Cryptocephalus distinguendus	2	0.0	100.0	100.0	1	1
DK	Other insect	Cucullia artemisiae	132	0.8	7.6	25.8	26	8
DK	Other insect	Cymindis angularis	2	0.0	0.0	100.0	2	0
DK	Other insect	Cymindis macularis	1	0.0	0.0	0.0	1	0
DK	Other insect	Cymindis vaporariorum	3	66.7	100.0	100.0	2	2
DK	Other insect	Cyrtopogon lateralis	3	0.0	0.0	0.0	2	1
DK	Other insect	Dasypolia templi	387	0.3	8.5	18.1	23	7
DK	Other insect	Diarsia dahlii	74	1.4	9.5	14.9	11	4
DK	Other insect	Dibolia occultans	1	0.0	0.0	0.0	1	0
DK	Other insect	Dichomeris ustalella	1	100.0	100.0	100.0	1	1
DK	Other insect	Dictyoptera aurora	5	20.0	100.0	100.0	2	2
DK	Other insect	Dolichus halensis	4	0.0	0.0	0.0	3	0
DK	Other insect	Doros profuges	2	0.0	0.0	50.0	2	0
DK	Other insect	Drymonia obliterata	152	25.7	31.6	32.2	13	3
DK	Other insect	Dryophthorus corticalis	7	0.0	0.0	0.0	1	0
DK	Other insect	Dyschirius chalceus	1	0.0	0.0	100.0	1	1
DK	Other insect	Eilema griseola	1496	1.2	14.6	34.0	92	40
DK	Other insect	Eilema pygmaeola	292	2.4	10.6	39.7	24	9
DK	Other insect	Elater ferrugineus	43	4.7	62.8	90.7	12	11

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Other insect	Endromis versicolora	167	0.6	44.3	72.5	13	4
DK	Other insect	Epaphius rivularis	1	100.0	100.0	100.0	1	1
DK	Other insect	Epilecta linogrisea	150	0.0	2.0	3.3	3	1
DK	Other insect	Epipsilia grisescens	12	16.7	8.3	25.0	2	1
DK	Other insect	Epistrophe grossulariae	30	3.3	10.0	33.3	12	4
DK	Other insect	Epistrophe melanostoma	2	0.0	100.0	100.0	2	2
DK	Other insect	Eremobia ochroleuca	420	2.6	13.3	22.6	137	43
DK	Other insect	Eriogaster lanestris	120	0.8	48.3	63.3	18	7
DK	Other insect	Eriozona syrphoides	170	4.1	11.8	25.3	45	14
DK	Other insect	Eristalis cryptarum	17	0.0	17.7	41.2	4	1
DK	Other insect	Eristalis ostracea	4	0.0	100.0	100.0	3	1
DK	Other insect	Eristalis rupium	7	14.3	42.9	57.1	4	3
DK	Other insect	Eucnemis capucina	7	0.0	0.0	0.0	1	1
DK	Other insect	Euheptaulacus villosus	4	0.0	75.0	100.0	3	1
DK	Other insect	Eumerus ornatus	57	0.0	54.4	63.2	11	4
DK	Other insect	Eumerus sogdianus	80	0.0	40.0	43.8	5	4
DK	Other insect	Eurydema dominulus	2	0.0	0.0	50.0	1	0
DK	Other insect	Eutolmus rufibarbis	12	8.3	58.3	83.3	8	3
DK	Other insect	Exocentrus lusitanus	11	0.0	45.5	72.7	5	1
DK	Other insect	Gastropacha quercifolia	39	0.0	94.9	97.4	3	0
DK	Other insect	Geotrupes stercorarius	61	42.6	59.0	68.9	15	7
DK	Other insect	Gnorimoschema herbichii	19	100.0	100.0	100.0	2	1
DK	Other insect	Gnorimus nobilis	34	73.5	79.4	79.4	5	3
DK	Other insect	Gnorimus variabilis	6	0.0	50.0	100.0	2	1
DK	Other insect	Gryllotalpa gryllotalpa	5	0.0	40.0	40.0	5	3
DK	Other insect	Habroloma nanum	2	0.0	50.0	100.0	2	0
DK	Other insect	Hadena albimacula	428	2.3	7.2	10.5	14	6
DK	Other insect	Hadena filograna	93	0.0	12.9	73.1	4	2
DK	Other insect	Hallomenus axillaris	1	0.0	100.0	100.0	1	0
DK	Other insect	Harpalus calceatus	7	0.0	0.0	0.0	2	0
DK	Other insect	Harpalus froelichii	1	0.0	0.0	0.0	1	0
DK	Other insect	Harpalus griseus	26	3.9	7.7	7.7	4	2
DK	Other insect	Heliothis maritima	96	7.3	69.8	86.5	19	10
DK	Other insect	Hemaris tityus	208	8.7	48.6	66.8	57	23
DK	Other insect	Herminia tarsicrinalis	74	2.7	25.7	36.5	25	9
DK	Other insect	Hoplia graminicola	2	0.0	100.0	100.0	1	0
DK	Other insect	Hoplia philanthus	8	12.5	100.0	100.0	5	2
DK	Other insect	Hoplodrina respersa	3	0.0	0.0	0.0	2	0
DK	Other insect	Hydraecia nordstroemi	1187	0.0	1.0	3.1	10	3
DK	Other insect	Hylobius pinastri	7	0.0	14.3	14.3	3	2
DK	Other insect	Hymenalia rufipes	2	0.0	100.0	100.0	2	1
DK	Other insect	Hyphoraia aulica	100	2.0	80.0	92.0	11	3
DK	Other insect	Hypulus quercinus	7	42.9	42.9	42.9	6	2
DK	Other insect	Ischnodes sanguinicollis	40	0.0	85.0	87.5	7	5
DK	Other insect	Ischnomera sanguinicollis	2	0.0	0.0	100.0	1	1
DK	Other insect	Jalla dumosa	26	50.0	92.3	96.2	9	4
DK	Other insect	Judolia sexmaculata	23	17.4	43.5	65.2	6	4
DK	Other insect	Labidostomis longimana	10	0.0	0.0	10.0	3	2
DK	Other insect	Lacanobia splendens	376	2.7	30.6	36.4	45	14
DK	Other insect	Lamprotes c-aureum	32	9.4	68.8	78.1	7	3
DK	Other insect	Laphria ephippium	29	13.8	34.5	34.5	8	5
DK	Other insect	Lasionhada proxima	5	0.0	80.0	100.0	1	1
DK	Other insect	Lasiorhynchites cavifrons	2	0.0	50.0	50.0	2	1
DK	Other insect	Lejogaster tarsata	75	1.3	24.0	34.7	12	6
DK	Other insect	Lejops vittata	11	0.0	72.7	100.0	5	2
DK	Other insect	Lemonia dumi	31	0.0	100.0	100.0	2	1
DK	Other insect	Leptarthrus brevirostris	2	100.0	100.0	100.0	1	0
DK	Other insect	Leptura aethiops	13	0.0	23.1	30.8	7	2
DK	Other insect	Lestes virens	51	2.0	74.5	96.1	8	4
DK	Other insect	Licinus depressus	2	50.0	50.0	50.0	2	1
DK	Other insect	Lithophane lamda	143	3.5	32.9	37.1	14	3
DK	Other insect	Lixus paraplecticus	14	0.0	0.0	71.4	1	0
DK	Other insect	Lucanus cervus	8	0.0	25.0	50.0	3	1
DK	Other insect	Lygephila craccae	43	0.0	69.8	72.1	6	2
DK	Other insect	Lygistopterus sanguineus	7	0.0	85.7	85.7	2	2
DK	Other insect	Lymexylon navale	7	14.3	42.9	42.9	5	4
DK	Other insect	Machimus arthriticus	3	33.3	66.7	66.7	3	2
DK	Other insect	Magdalis armigera	19	5.3	15.8	15.8	10	6
DK	Other insect	Malachius aeneus	5	60.0	80.0	80.0	4	3

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Other insect	Malacosoma neustria	993	4.6	23.4	40.9	102	33
DK	Other insect	Mallota cimbiciformis	27	3.7	37.0	51.9	5	3
DK	Other insect	Melandrya dubia	2	0.0	0.0	0.0	2	1
DK	Other insect	Melangyna lucifera	11	0.0	0.0	27.3	6	3
DK	Other insect	Melasis buprestoides	28	10.7	32.1	57.1	8	5
DK	Other insect	Meloe brevicollis	3	0.0	100.0	100.0	2	1
DK	Other insect	Merodon avidus	19	0.0	5.3	5.3	3	2
DK	Other insect	Metzneria santolinella	6	0.0	0.0	0.0	2	1
DK	Other insect	Microdon analis	42	2.4	23.8	42.9	15	9
DK	Other insect	Microdon myrmicae	29	0.0	72.4	86.2	16	10
DK	Other insect	Monochroa rumicetella	1	0.0	0.0	0.0	1	1
DK	Other insect	Mycetochara flavipes	1	0.0	0.0	100.0	1	1
DK	Other insect	Mycetophagus fulvicollis	9	0.0	100.0	100.0	2	2
DK	Other insect	Myolepta dubia	72	0.0	8.3	11.1	6	4
DK	Other insect	Mythimna turca	239	0.0	6.7	20.9	30	9
DK	Other insect	Nehalennia speciosa	53	0.0	100.0	100.0	1	1
DK	Other insect	Neomida haemorrhoidalis	28	14.3	53.6	78.6	4	3
DK	Other insect	Nola aerugula	630	2.4	12.5	17.5	32	9
DK	Other insect	Nosodendron fasciculare	3	0.0	66.7	66.7	2	2
DK	Other insect	Notodonta torva	128	0.0	55.5	61.7	11	3
DK	Other insect	Nudaria mundana	546	0.2	5.5	7.0	23	8
DK	Other insect	Oberea linearis	7	0.0	14.3	14.3	5	4
DK	Other insect	Oberea oculata	7	0.0	28.6	42.9	4	1
DK	Other insect	Ocys quinquestriatus	1	0.0	0.0	0.0	1	1
DK	Other insect	Odontoscelis fuliginosa	51	3.9	13.7	37.3	30	9
DK	Other insect	Odontoscelis lineola	12	16.7	66.7	75.0	8	2
DK	Other insect	Oedipoda caerulescens	9	0.0	0.0	100.0	1	0
DK	Other insect	Omaloplia nigromarginata	14	92.9	100.0	100.0	2	2
DK	Other insect	Omocestus haemorrhoidalis	14	100.0	100.0	100.0	1	1
DK	Other insect	Onthophagus joannae	5	20.0	40.0	60.0	4	2
DK	Other insect	Onthophagus vacca	21	4.8	85.7	85.7	6	6
DK	Other insect	Ophonus rupicola	1	100.0	100.0	100.0	1	1
DK	Other insect	Oplosia cinerea	4	0.0	100.0	100.0	1	0
DK	Other insect	Orgyia antiquoides	79	19.0	51.9	67.1	34	12
DK	Other insect	Orgyia recens	40	77.5	80.0	95.0	4	1
DK	Other insect	Orsodacne cerasi	4	0.0	100.0	100.0	1	0
DK	Other insect	Orthetrum coerulescens	110	0.0	53.6	82.7	26	12
DK	Other insect	Orthonevra elegans	2	0.0	50.0	100.0	2	1
DK	Other insect	Osphya bipunctata	4	0.0	0.0	75.0	2	0
DK	Other insect	Otiorhynchus rugifrons	3	0.0	33.3	66.7	1	0
DK	Other insect	Pabulatrix pabulatricula	23	100.0	100.0	100.0	1	0
DK	Other insect	Pachetra sagittigera	210	1.9	54.8	59.1	22	10
DK	Other insect	Panemeria tenebrata	95	1.1	9.5	23.2	20	7
DK	Other insect	Paracolax tristalis	12	0.0	8.3	16.7	7	4
DK	Other insect	Paragus albifrons	1	0.0	0.0	0.0	1	0
DK	Other insect	Paragus finitimus	38	2.6	18.4	50.0	12	3
DK	Other insect	Paragus tibialis	5	0.0	80.0	100.0	5	1
DK	Other insect	Paraphotistus nigricornis	1	100.0	100.0	100.0	1	0
DK	Other insect	Parasemia plantaginis	78	9.0	21.8	38.5	29	16
DK	Other insect	Pedostrangalia revestita	8	0.0	50.0	50.0	4	2
DK	Other insect	Peltis ferruginea	21	23.8	95.2	100.0	4	2
DK	Other insect	Pentaphyllus testaceus	10	0.0	100.0	100.0	1	1
DK	Other insect	Philorhizus quadrisignatus	2	0.0	100.0	100.0	1	1
DK	Other insect	Phimodera humeralis	15	13.3	13.3	93.3	2	0
DK	Other insect	Photedes captiuncula	34	0.0	100.0	100.0	1	1
DK	Other insect	Photedes morrisii	286	21.0	30.1	36.7	24	7
DK	Other insect	Phragmatiphila nexa	163	6.8	16.6	49.1	27	14
DK	Other insect	Phytometra viridaria	196	6.6	25.5	76.5	25	7
DK	Other insect	Pipiza austriaca	7	0.0	28.6	28.6	3	2
DK	Other insect	Pipiza luteitarsis	20	0.0	15.0	30.0	10	4
DK	Other insect	Pissodes validirostris	13	0.0	92.3	92.3	3	2
DK	Other insect	Plagionotus detritus	19	0.0	63.2	63.2	3	1
DK	Other insect	Platycheirus immarginatus	32	9.4	21.9	56.3	9	3
DK	Other insect	Platycheirus podagratus	27	0.0	44.4	48.2	3	2
DK	Other insect	Platycheirus transfugus	2	50.0	50.0	50.0	2	1
DK	Other insect	Platycnemis pennipes	75	0.0	44.0	92.0	6	3
DK	Other insect	Platynus krynickii	4	0.0	100.0	100.0	2	2
DK	Other insect	Pocota personata	19	0.0	10.5	47.4	5	4
DK	Other insect	Podistra schoenherri	1	100.0	100.0	100.0	1	1

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Other insect	Pogonocherus decoratus	7	0.0	0.0	0.0	2	2
DK	Other insect	Pogonus luridipennis	1	0.0	100.0	100.0	1	0
DK	Other insect	Polymixis flavicincta	11	0.0	0.0	0.0	2	1
DK	Other insect	Polymixis polymita	566	0.4	4.6	8.7	41	15
DK	Other insect	Polypogon tentacularia	1	0.0	0.0	0.0	1	0
DK	Other insect	Prostomis mandibularis	11	0.0	0.0	100.0	1	0
DK	Other insect	Protolampra sobrina	5	0.0	20.0	20.0	5	2
DK	Other insect	Pseudeustrotia candidula	1550	1.1	5.7	10.3	79	25
DK	Other insect	Pterostichus aterrimus	2	0.0	0.0	100.0	1	0
DK	Other insect	Ptilophora plumigera	120	0.0	0.0	1.7	7	1
DK	Other insect	Ptocheuusa inopella	1	0.0	0.0	0.0	1	1
DK	Other insect	Pyrrhidium sanguineum	70	7.1	22.9	50.0	27	15
DK	Other insect	Pytho depressus	56	3.6	78.6	78.6	11	6
DK	Other insect	Rhagades pruni	81	3.7	50.6	70.4	15	2
DK	Other insect	Rhynchaenus alni	2	0.0	0.0	0.0	2	1
DK	Other insect	Rhynchaenus calceatus	6	0.0	0.0	100.0	1	1
DK	Other insect	Rhynchaenus rufus	24	0.0	4.2	12.5	16	8
DK	Other insect	Rusticoclytus rusticus	4	0.0	0.0	25.0	2	1
DK	Other insect	Schrankia taenialis	40	0.0	92.5	92.5	2	0
DK	Other insect	Scolytus laevis	3	0.0	0.0	0.0	2	1
DK	Other insect	Scolytus scolytus	1	0.0	100.0	100.0	1	1
DK	Other insect	Setina irrorella	307	16.0	28.7	56.0	48	17
DK	Other insect	Shargacucullia lychnitis	50	0.0	10.0	24.0	14	4
DK	Other insect	Shargacucullia scrophulariae	242	1.2	8.7	16.9	31	8
DK	Other insect	Sigara hellensii	1	0.0	0.0	100.0	1	0
DK	Other insect	Smaragdina salicina	7	0.0	42.9	71.4	1	0
DK	Other insect	Somatochlora arctica	53	7.6	81.1	98.1	7	4
DK	Other insect	Sophronia chilonella	2	0.0	0.0	0.0	1	0
DK	Other insect	Spaelotis ravida	418	1.4	6.2	11.0	53	19
DK	Other insect	Spathocera dalmanii	1	0.0	0.0	0.0	1	0
DK	Other insect	Sphaerophoria loewi	10	0.0	80.0	100.0	9	8
DK	Other insect	Sphaerophoria rueppelli	30	6.7	23.3	53.3	12	3
DK	Other insect	Spiris striata	238	0.4	68.5	87.4	14	6
DK	Other insect	Stagonomus bipunctatus	7	0.0	42.9	42.9	4	2
DK	Other insect	Stictoleptura scutellata	70	11.4	54.3	61.4	18	10
DK	Other insect	Tachyta nana	2	0.0	50.0	50.0	2	2
DK	Other insect	Temnostoma apiforme	4	75.0	100.0	100.0	4	2
DK	Other insect	Temnostoma meridionale	57	1.8	26.3	43.9	10	6
DK	Other insect	Tenebrio opacus	8	0.0	0.0	87.5	2	0
DK	Other insect	Tetrops starkii	9	0.0	33.3	33.3	5	2
DK	Other insect	Thymalus limbatus	13	15.4	100.0	100.0	4	3
DK	Other insect	Trachys minutus	1	0.0	0.0	100.0	1	0
DK	Other insect	Trachys scrobiculatus	2	0.0	0.0	0.0	1	0
DK	Other insect	Trichiura crataegi	211	1.9	22.3	34.6	31	11
DK	Other insect	Trichopsomyia joratensis	9	0.0	0.0	0.0	5	2
DK	Other insect	Trixagus exul	1	0.0	0.0	0.0	1	0
DK	Other insect	Trox hispidus	2	0.0	100.0	100.0	2	1
DK	Other insect	Typhaeus typhoeus	169	5.9	45.6	86.4	26	8
DK	Other insect	Tyta luctuosa	35	2.9	2.9	8.6	15	4
DK	Other insect	Volucella inanis	12	0.0	0.0	8.3	8	3
DK	Other insect	Xanthogramma festivum	42	2.4	40.5	57.1	18	7
DK	Other insect	Xestia agathina	423	8.3	46.1	66.7	20	6
DK	Other insect	Xestia ditrapezium	33	3.0	6.1	9.1	9	3
DK	Other insect	Xylophilus corticalis	7	42.9	71.4	71.4	2	1
DK	Other insect	Xylota abiens	40	0.0	22.5	30.0	11	3
DK	Other insect	Xylota meigeniana	5	0.0	20.0	20.0	3	0
DK	Other insect	Zygaena lonicerae	862	12.1	42.2	58.9	211	87
DK	Other insect	Zygaena minos	533	3.0	48.0	75.6	59	27
DK	Other insect	Zygaena purpuralis	213	97.2	98.1	99.1	7	5
DK	Other insect	Zygaena trifolii	162	14.8	52.5	77.8	64	26
DK	Other insect	Zygaena viciae	330	1.2	58.2	70.3	42	20
DK	Other invertebrate	Araneus alsine	32	25.0	62.5	81.3	10	4
DK	Other invertebrate	Araneus angulatus	23	30.4	69.6	78.3	8	5
DK	Other invertebrate	Araneus marmoreus	95	23.2	63.2	83.2	34	17
DK	Other invertebrate	Araneus triguttatus	33	0.0	6.1	6.1	5	3
DK	Other invertebrate	Dendryphantes rudis	13	0.0	100.0	100.0	2	1
DK	Other invertebrate	Enoplognatha oelandica	1	100.0	0.0	100.0	1	1
DK	Other invertebrate	Eresus sandaliatus	240	15.8	48.8	71.3	50	21
DK	Other invertebrate	Heliophanus dampfi	16	43.8	56.3	62.5	6	2

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Other invertebrate	Hygrolycosa rubrofasciata	15	53.3	93.3	100.0	5	2
DK	Other invertebrate	Lepidurus apus	25	0.0	56.0	84.0	5	3
DK	Other invertebrate	Marpissa radiata	3	0.0	33.3	100.0	2	2
DK	Other invertebrate	Midia midas	8	0.0	12.5	12.5	2	1
DK	Other invertebrate	Oxyopes ramosus	29	3.5	72.4	86.2	6	4
DK	Other invertebrate	Pirata latitans	4	25.0	100.0	100.0	2	2
DK	Other invertebrate	Segestria bavarica	12	0.0	91.7	91.7	2	1
DK	Other invertebrate	Thanatus formicinus	8	100.0	100.0	100.0	1	1
DK	Other invertebrate	Xerolycosa miniata	11	0.0	0.0	63.6	6	1
DK	Fungi	Agaricus devoniensis	7	0.0	71.4	100.0	5	2
DK	Fungi	Agaricus moelleri	53	17.0	26.4	34.0	19	10
DK	Fungi	Agaricus phaeolepidotus	19	5.3	42.1	47.4	8	5
DK	Fungi	Agaricus porphyrizon	37	8.1	35.1	46.0	25	13
DK	Fungi	Agrocybe firma	9	0.0	44.4	55.6	6	2
DK	Fungi	Agrocybe vervacti	13	0.0	38.5	61.5	10	5
DK	Fungi	Albatrellus pes-caprae	26	26.9	53.9	76.9	3	2
DK	Fungi	Aleurodiscus disciformis	28	100.0	100.0	100.0	2	1
DK	Fungi	Amanita eliae	1	0.0	0.0	0.0	1	0
DK	Fungi	Amanita lividopallescens	27	0.0	11.1	25.9	9	2
DK	Fungi	Amanita olivaceogrisea	7	42.9	85.7	100.0	5	3
DK	Fungi	Amanita solitaria	25	60.0	92.0	96.0	3	3
DK	Fungi	Amanita strobiliformis	153	20.3	30.1	32.7	22	12
DK	Fungi	Amaurodon cyaneus	3	0.0	100.0	100.0	2	2
DK	Fungi	Anomoporia myceliosa	9	0.0	55.6	55.6	4	1
DK	Fungi	Antrodia heteromorpha	7	0.0	100.0	100.0	1	1
DK	Fungi	Antrodia malicola	47	4.3	21.3	72.3	31	13
DK	Fungi	Armillaria ectypa	8	0.0	100.0	100.0	3	3
DK	Fungi	Arrhenia epichysium	15	80.0	86.7	86.7	5	4
DK	Fungi	Arrhenia lobata	32	6.3	43.8	84.4	23	11
DK	Fungi	Athelidium aurantiacum	5	80.0	100.0	100.0	3	2
DK	Fungi	Aurantiporus alborubescens	172	11.1	41.3	54.1	29	15
DK	Fungi	Aurantiporus croceus	36	0.0	100.0	100.0	1	1
DK	Fungi	Aureoboletus gentilis	137	9.5	21.9	24.1	22	8
DK	Fungi	Bankera fuligineoalba	34	2.9	44.1	61.8	9	5
DK	Fungi	Bankera violascens	74	0.0	36.5	36.5	11	6
DK	Fungi	Boletopsis leucomelaena	5	0.0	0.0	0.0	2	1
DK	Fungi	Boletus aereus	89	6.7	18.0	24.7	30	12
DK	Fungi	Boletus queletii	1	0.0	0.0	0.0	1	0
DK	Fungi	Buchwaldoboletus lignicola	25	4.0	44.0	56.0	10	5
DK	Fungi	Buglossoporus quercinus	126	19.8	82.5	90.5	12	9
DK	Fungi	Calocera glossoides	21	14.3	38.1	66.7	6	4
DK	Fungi	Camarophyllopsis atropuncta	17	0.0	23.5	23.5	8	4
DK	Fungi	Camarophyllopsis hymenocephala	37	2.7	40.5	46.0	22	8
DK	Fungi	Camarophyllopsis micacea	11	9.1	27.3	63.6	8	4
DK	Fungi	Ceriporia purpurea	73	12.3	39.7	52.1	45	18
DK	Fungi	Ceriporiopsis gilvescens	47	34.0	57.5	63.8	7	6
DK	Fungi	Ceriporiopsis pannocincta	16	37.5	43.8	56.3	9	6
DK	Fungi	Cerrena unicolor	82	12.2	47.6	63.4	29	12
DK	Fungi	Chamaemyces fracidus	25	60.0	84.0	84.0	9	7
DK	Fungi	Cheimonophyllum candidissimum	11	45.5	90.9	90.9	3	2
DK	Fungi	Choiromyces meandriformis	8	0.0	0.0	0.0	3	1
DK	Fungi	Chromocyphella muscicola	12	0.0	83.3	83.3	4	3
DK	Fungi	Clavaria amoenoides	10	0.0	40.0	90.0	7	3
DK	Fungi	Clavaria asperulispora	7	42.9	42.9	85.7	5	2
DK	Fungi	Clavaria flavipes	35	8.6	42.9	94.3	13	7
DK	Fungi	Clavaria fumosa	51	3.9	70.6	82.4	21	9
DK	Fungi	Clavaria macouni	4	75.0	75.0	75.0	2	0
DK	Fungi	Clavaria tenuipes	1	0.0	0.0	0.0	1	1
DK	Fungi	Clavaria zollingeri	28	0.0	64.3	82.1	6	2
DK	Fungi	Clavicorona taxophila	15	6.7	53.3	66.7	11	7
DK	Fungi	Clavulinopsis cinereoides	92	4.4	47.8	71.7	33	17
DK	Fungi	Clavulinopsis fusiformis	16	6.3	31.3	87.5	7	2
DK	Fungi	Clavulinopsis microspora	31	6.5	32.3	58.1	20	7
DK	Fungi	Climacocystis borealis	25	20.0	36.0	48.0	10	5
DK	Fungi	Clitocybe alexandri	26	0.0	7.7	26.9	9	5
DK	Fungi	Coltricia confluens	19	5.3	21.1	31.6	11	7
DK	Fungi	Conocybe dumetorum	8	12.5	37.5	62.5	5	3
DK	Fungi	Coprinopsis insignis	14	14.3	92.9	92.9	4	3
DK	Fungi	Coprinopsis pannucioides	5	20.0	40.0	60.0	5	1

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Fungi	Coprinopsis spelaiophila	9	11.1	33.3	55.6	6	2
DK	Fungi	Corticium expallens	1	0.0	0.0	0.0	1	0
DK	Fungi	Cortinarius acetosus	18	5.6	0.0	5.6	13	4
DK	Fungi	Cortinarius albertii	7	0.0	0.0	0.0	1	0
DK	Fungi	Cortinarius alborufescens	5	0.0	0.0	0.0	2	0
DK	Fungi	Cortinarius arcuatorum	16	0.0	0.0	12.5	4	1
DK	Fungi	Cortinarius areni-silvae	4	0.0	0.0	0.0	2	0
DK	Fungi	Cortinarius armeniacus	2	0.0	0.0	0.0	1	1
DK	Fungi	Cortinarius aureocalceolatus	15	40.0	66.7	66.7	5	3
DK	Fungi	Cortinarius betulinus	14	7.1	28.6	100.0	5	4
DK	Fungi	Cortinarius bulliardii	16	0.0	12.5	18.8	6	1
DK	Fungi	Cortinarius caesiocortinatus	59	25.4	42.4	72.9	11	6
DK	Fungi	Cortinarius caesiolatens	117	6.8	32.5	37.6	14	9
DK	Fungi	Cortinarius caesiostramineus	10	40.0	70.0	70.0	5	3
DK	Fungi	Cortinarius cagei	18	0.0	16.7	22.2	10	3
DK	Fungi	Cortinarius camphoratus	15	6.7	53.3	53.3	11	4
DK	Fungi	Cortinarius caperatus	215	6.5	48.4	53.5	33	19
DK	Fungi	Cortinarius catharinae	17	76.5	88.2	88.2	4	3
DK	Fungi	Cortinarius cinnabarinus	93	5.4	33.3	45.2	40	23
DK	Fungi	Cortinarius cisticola	7	0.0	42.9	57.1	4	4
DK	Fungi	Cortinarius cliduchus	12	0.0	50.0	50.0	5	2
DK	Fungi	Cortinarius coerulescentium	11	0.0	0.0	0.0	1	0
DK	Fungi	Cortinarius colus	1	0.0	0.0	0.0	1	0
DK	Fungi	Cortinarius cotoneus	80	38.8	45.0	48.8	18	8
DK	Fungi	Cortinarius elegantissimus	136	25.0	55.9	62.5	20	10
DK	Fungi	Cortinarius emunctus	1	0.0	100.0	100.0	1	1
DK	Fungi	Cortinarius eucaeruleus	36	0.0	11.1	36.1	4	2
DK	Fungi	Cortinarius flavovirens	15	0.0	0.0	20.0	7	3
DK	Fungi	Cortinarius fragrantior	2	0.0	50.0	50.0	2	0
DK	Fungi	Cortinarius fulvocitrinus	30	63.3	80.0	80.0	3	1
DK	Fungi	Cortinarius gracilior	5	100.0	100.0	100.0	2	1
DK	Fungi	Cortinarius humicola	17	0.0	70.6	70.6	3	2
DK	Fungi	Cortinarius humolens	12	0.0	75.0	83.3	4	2
DK	Fungi	Cortinarius imperialis	15	0.0	6.7	6.7	3	0
DK	Fungi	Cortinarius insignibulbus	3	100.0	100.0	100.0	2	1
DK	Fungi	Cortinarius langeorum	24	41.7	91.7	91.7	5	2
DK	Fungi	Cortinarius leucophanes	18	0.0	88.9	88.9	3	1
DK	Fungi	Cortinarius lilacinovelatus	31	64.5	77.4	77.4	6	4
DK	Fungi	Cortinarius luteoimmarginatus	3	0.0	100.0	100.0	1	0
DK	Fungi	Cortinarius maculosus	3	0.0	100.0	100.0	1	0
DK	Fungi	Cortinarius magicus	12	66.7	83.3	83.3	3	1
DK	Fungi	Cortinarius multiformium	28	53.6	67.9	89.3	7	3
DK	Fungi	Cortinarius nanceiensis	6	100.0	100.0	100.0	2	1
DK	Fungi	Cortinarius nymphicolor	3	33.3	33.3	33.3	2	0
DK	Fungi	Cortinarius odoratus	35	0.0	0.0	0.0	3	0
DK	Fungi	Cortinarius olearioides	70	1.4	14.3	32.9	22	11
DK	Fungi	Cortinarius orellanus	10	10.0	60.0	60.0	7	6
DK	Fungi	Cortinarius osmophorus	62	51.6	77.4	80.7	9	6
DK	Fungi	Cortinarius porphyropus	8	0.0	0.0	25.0	7	6
DK	Fungi	Cortinarius quarciticus	26	23.1	69.2	73.1	5	2
DK	Fungi	Cortinarius rufo-olivaceus	71	18.3	40.9	49.3	15	6
DK	Fungi	Cortinarius saporatus	30	93.3	93.3	93.3	3	1
DK	Fungi	Cortinarius selandicus	15	26.7	53.3	53.3	7	3
DK	Fungi	Cortinarius serratissimus	4	25.0	50.0	75.0	4	3
DK	Fungi	Cortinarius sodagnitus	42	59.5	69.1	71.4	9	5
DK	Fungi	Cortinarius splendens	39	48.7	69.2	74.4	7	5
DK	Fungi	Cortinarius suaveolens	9	0.0	22.2	22.2	3	1
DK	Fungi	Cortinarius talus	59	11.9	25.4	45.8	28	12
DK	Fungi	Cortinarius tophaceus	5	0.0	80.0	80.0	3	1
DK	Fungi	Cortinarius traganus	64	4.7	10.9	12.5	11	3
DK	Fungi	Cortinarius urbicus	12	0.0	16.7	66.7	8	3
DK	Fungi	Cortinarius variiformis	4	0.0	0.0	0.0	1	0
DK	Fungi	Cortinarius venustus	7	0.0	0.0	0.0	3	1
DK	Fungi	Cortinarius vesterholtii	6	0.0	66.7	66.7	2	2
DK	Fungi	Cortinarius violaceocinereus	6	0.0	16.7	50.0	5	1
DK	Fungi	Cortinarius xanthochlorus	10	0.0	0.0	0.0	2	0
DK	Fungi	Cortinarius xantho-ochraceus	49	4.1	44.9	44.9	14	4
DK	Fungi	Cotylidia pannosa	8	0.0	12.5	50.0	3	2
DK	Fungi	Craterellus cinereus	144	3.5	29.9	39.6	37	20

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Fungi	Craterellus melanoxeros	21	14.3	66.7	76.2	8	5
DK	Fungi	Crepidotus cinnabarinus	8	0.0	62.5	62.5	4	2
DK	Fungi	Cristinia gallica	30	73.3	80.0	80.0	7	3
DK	Fungi	Cystolepiota hetieri	70	15.7	28.6	37.1	19	11
DK	Fungi	Cystolepiota icterina	26	19.2	23.1	34.6	6	3
DK	Fungi	Cystolepiota moelleri	35	20.0	48.6	60.0	16	11
DK	Fungi	Dacrymyces enatus	9	44.4	44.4	44.4	6	3
DK	Fungi	Dendrocollybia racemosa	10	0.0	60.0	70.0	8	5
DK	Fungi	Dendrothele commixta	22	27.3	68.2	86.4	16	9
DK	Fungi	Dentipellis fragilis	20	75.0	100.0	100.0	5	3
DK	Fungi	Dermoloma pseudocuneifolium	84	10.7	61.9	73.8	25	19
DK	Fungi	Dichomitus campestris	37	2.7	43.2	54.1	17	8
DK	Fungi	Disciseda bovista	2	0.0	50.0	100.0	2	2
DK	Fungi	Disciseda candida	2	50.0	100.0	100.0	2	2
DK	Fungi	Echinoderma boertmannii	11	54.6	54.6	54.6	2	2
DK	Fungi	Echinoderma calcicola	34	52.9	64.7	64.7	7	4
DK	Fungi	Echinoderma hystrix	50	14.0	20.0	34.0	18	12
DK	Fungi	Echinoderma perplexum	31	35.5	48.4	51.6	9	5
DK	Fungi	Echinoderma pseudoasperulum	32	12.5	21.9	34.4	11	4
DK	Fungi	Elaphomyces anthracinus	1	0.0	100.0	100.0	1	1
DK	Fungi	Entoloma ameides	20	15.0	55.0	75.0	9	7
DK	Fungi	Entoloma anatinum	67	13.4	50.8	82.1	18	10
DK	Fungi	Entoloma aprile	16	12.5	6.3	37.5	14	6
DK	Fungi	Entoloma bloxamii	31	0.0	22.6	58.1	11	7
DK	Fungi	Entoloma caeruleopolitum	3	0.0	0.0	33.3	2	2
DK	Fungi	Entoloma caesiocinctum	43	25.6	69.8	88.4	24	15
DK	Fungi	Entoloma callirhodon	1	0.0	0.0	100.0	1	1
DK	Fungi	Entoloma clandestinum	26	15.4	69.2	96.2	17	12
DK	Fungi	Entoloma cocles	56	0.0	41.1	78.6	15	8
DK	Fungi	Entoloma corvinum	53	22.6	50.9	83.0	25	12
DK	Fungi	Entoloma cruentatum	5	0.0	60.0	100.0	4	2
DK	Fungi	Entoloma cuspidiferum	5	20.0	100.0	100.0	2	2
DK	Fungi	Entoloma depluens	2	0.0	50.0	50.0	2	1
DK	Fungi	Entoloma dichroum	21	33.3	52.4	57.1	9	7
DK	Fungi	Entoloma elodes	12	25.0	91.7	91.7	9	4
DK	Fungi	Entoloma formosum	47	14.9	38.3	76.6	25	10
DK	Fungi	Entoloma fuscomarginatum	2	0.0	100.0	100.0	2	2
DK	Fungi	Entoloma glaucobasis	14	21.4	35.7	78.6	5	2
DK	Fungi	Entoloma griseocyaneum	220	5.9	52.7	75.9	64	30
DK	Fungi	Entoloma hirtum	3	0.0	33.3	100.0	2	1
DK	Fungi	Entoloma hispidulum	6	16.7	50.0	100.0	4	1
DK	Fungi	Entoloma huijsmanii	3	0.0	66.7	100.0	3	3
DK	Fungi	Entoloma indutoides	1	0.0	100.0	100.0	1	1
DK	Fungi	Entoloma jubatum	21	4.8	33.3	47.6	14	7
DK	Fungi	Entoloma juniperinum	2	0.0	50.0	50.0	2	1
DK	Fungi	Entoloma lampropus	16	0.0	6.3	56.3	6	3
DK	Fungi	Entoloma lepidissimum	10	10.0	20.0	60.0	9	6
DK	Fungi	Entoloma lividocyanulum	63	12.7	58.7	74.6	25	15
DK	Fungi	Entoloma longistriatum	75	10.7	61.3	76.0	27	17
DK	Fungi	Entoloma mougeotii	49	22.5	87.8	95.9	15	9
DK	Fungi	Entoloma neglectum	17	23.5	52.9	64.7	13	7
DK	Fungi	Entoloma ortonii	1	0.0	0.0	100.0	1	0
DK	Fungi	Entoloma parkensis	15	0.0	46.7	60.0	8	5
DK	Fungi	Entoloma placidum	13	15.4	53.9	69.2	10	6
DK	Fungi	Entoloma plebejum	3	0.0	0.0	66.7	3	1
DK	Fungi	Entoloma porphyrogriseum	9	55.6	88.9	100.0	3	1
DK	Fungi	Entoloma porphyrophaeum	41	2.4	29.3	70.7	15	8
DK	Fungi	Entoloma prunuloides	255	4.3	46.7	73.7	56	24
DK	Fungi	Entoloma queletii	26	3.9	26.9	46.2	8	2
DK	Fungi	Entoloma rhombisporum	45	20.0	60.0	71.1	11	8
DK	Fungi	Entoloma roseum	3	0.0	100.0	100.0	1	1
DK	Fungi	Entoloma scabropellis	29	0.0	31.0	72.4	13	6
DK	Fungi	Entoloma scabrosum	11	9.1	45.5	54.6	6	5
DK	Fungi	Entoloma sinuatum	92	1.1	16.3	19.6	24	10
DK	Fungi	Entoloma sodale	47	8.5	51.1	59.6	16	7
DK	Fungi	Entoloma solstitiale	37	2.7	32.4	56.8	14	8
DK	Fungi	Entoloma sphagneti	1	0.0	0.0	100.0	1	1
DK	Fungi	Entoloma strigosissimum	3	0.0	66.7	66.7	3	3
DK	Fungi	Entoloma transvenosum	2	0.0	100.0	100.0	2	2

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Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Fungi	Entoloma turci	45	20.0	82.2	88.9	18	15
DK	Fungi	Entoloma weholtii	20	60.0	80.0	80.0	6	5
DK	Fungi	Entoloma xanthochroum	13	7.7	30.8	92.3	8	3
DK	Fungi	Erythricium aurantiacum	33	6.1	18.2	33.3	19	8
DK	Fungi	Exidia cartilaginea	10	20.0	70.0	90.0	6	4
DK	Fungi	Exidia repanda	7	85.7	85.7	85.7	2	0
DK	Fungi	Faerberia carbonaria	5	0.0	60.0	60.0	3	1
DK	Fungi	Femsjonia peziziformis	4	0.0	50.0	50.0	1	0
DK	Fungi	Flammulaster limulatus	21	47.6	76.2	81.0	12	5
DK	Fungi	Flammulaster muricata	30	60.0	86.7	86.7	11	7
DK	Fungi	Flammulaster novasilvensis	3	66.7	100.0	100.0	2	1
DK	Fungi	Fomitiporia robusta	27	7.4	59.3	59.3	8	7
DK	Fungi	Ganoderma resinaceum	67	0.0	7.5	17.9	19	7
DK	Fungi	Geastrum corollinum	7	0.0	100.0	100.0	3	3
DK	Fungi	Geastrum elegans	13	7.7	69.2	84.6	6	4
DK	Fungi	Geastrum minimum	17	0.0	82.4	94.1	11	6
DK	Fungi	Geastrum quadrifidum	15	20.0	0.0	26.7	6	3
DK	Fungi	Geoglossum atropurpureum	60	1.7	76.7	91.7	21	13
DK	Fungi	Geoglossum difforme	3	0.0	66.7	66.7	1	1
DK	Fungi	Geoglossum littorale	2	0.0	100.0	100.0	2	2
DK	Fungi	Geoglossum sphagnophilum	9	0.0	55.6	77.8	2	2
DK	Fungi	Geoglossum starbaeckii	29	3.5	41.4	69.0	13	6
DK	Fungi	Gloeocystidiellum clavuligerum	4	50.0	75.0	75.0	4	2
DK	Fungi	Gloeohypochnicium analogum	48	37.5	58.3	70.8	13	7
DK	Fungi	Gloeoporus dichrous	45	42.2	82.2	86.7	15	9
DK	Fungi	Gomphus clavatus	17	0.0	41.2	41.2	3	1
DK	Fungi	Gymnopus brassicolens	74	46.0	63.5	67.6	15	8
DK	Fungi	Gymnopus hariolorum	32	0.0	0.0	0.0	9	4
DK	Fungi	Gymnopus impudicus	11	9.1	36.4	54.6	7	5
DK	Fungi	Gymnopus inodorus	11	0.0	0.0	9.1	9	2
DK	Fungi	Gyromitra fastigiata	2	100.0	100.0	100.0	1	0
DK	Fungi	Gyromitra gigas	34	0.0	2.9	2.9	6	4
DK	Fungi	Gyromitra parma	9	100.0	100.0	100.0	1	0
DK	Fungi	Hebeloma alvarense	2	0.0	0.0	0.0	1	0
DK	Fungi	Hebeloma fusisporum	29	0.0	27.6	44.8	18	5
DK	Fungi	Helvella albella	3	33.3	66.7	100.0	3	0
DK	Fungi	Helvella costifera	10	0.0	40.0	70.0	3	1
DK	Fungi	Helvella queletii	31	0.0	41.9	41.9	10	5
DK	Fungi	Hemipholiota heteroclita	40	2.5	55.0	75.0	19	10
DK	Fungi	Hericium cirrhatum	130	13.9	31.5	37.7	33	17
DK	Fungi	Hericium erinaceus	99	6.1	67.7	70.7	13	8
DK	Fungi	Hohenbuehelia atrocoerulea	26	7.7	30.8	57.7	11	5
DK	Fungi	Hohenbuehelia auriscalpium	27	51.9	59.3	66.7	10	6
DK	Fungi	Hohenbuehelia mastrucata	31	32.3	51.6	67.7	18	5
DK	Fungi	Hohenbuehelia petaloides	14	14.3	28.6	28.6	6	4
DK	Fungi	Hohenbuehelia unguicularis	7	0.0	14.3	14.3	6	3
DK	Fungi	Hydnellum aurantiacum	114	1.8	14.9	19.3	7	4
DK	Fungi	Hydnellum auratile	16	100.0	100.0	100.0	1	1
DK	Fungi	Hydnellum caeruleum	72	5.6	37.5	68.1	9	5
DK	Fungi	Hydnellum concrescens	243	2.5	36.2	50.6	38	20
DK	Fungi	Hydnellum ferrugineum	92	0.0	31.5	33.7	18	6
DK	Fungi	Hydnellum gracilipes	5	0.0	40.0	40.0	1	0
DK	Fungi	Hydnellum peckii	49	0.0	4.1	12.2	11	5
DK	Fungi	Hydnellum scrobiculatum	1	0.0	0.0	0.0	1	0
DK	Fungi	Hydnellum spongiosipes	45	2.2	35.6	40.0	6	3
DK	Fungi	Hydnum albidum	65	56.9	70.8	98.5	6	4
DK	Fungi	Hydropus scabripes	5	40.0	40.0	40.0	3	2
DK	Fungi	Hydropus trichoderma	11	72.7	90.9	100.0	3	2
DK	Fungi	Hygrocybe aurantiosplendens	53	0.0	50.9	75.5	17	9
DK	Fungi	Hygrocybe calciphila	42	16.7	64.3	76.2	17	10
DK	Fungi	Hygrocybe calyptriformis	9	55.6	55.6	88.9	4	3
DK	Fungi	Hygrocybe coccineocrenata	114	3.5	49.1	70.2	42	19
DK	Fungi	Hygrocybe colemanniana	100	0.0	64.0	76.0	30	14
DK	Fungi	Hygrocybe constrictospora	8	0.0	75.0	100.0	4	2
DK	Fungi	Hygrocybe flavipes	234	1.7	35.5	66.2	52	20
DK	Fungi	Hygrocybe fornicata	154	4.6	57.1	77.9	53	26
DK	Fungi	Hygrocybe intermedia	84	2.4	69.1	81.0	18	13
DK	Fungi	Hygrocybe lacma	27	7.4	51.9	81.5	14	7
DK	Fungi	Hygrocybe ovina	136	2.2	53.7	75.7	30	16

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Fungi	Hygrocybe punicea	413	3.6	49.2	77.2	98	42
DK	Fungi	Hygrocybe quieta	232	2.6	43.5	68.1	60	29
DK	Fungi	Hygrocybe radiata	72	4.2	40.3	63.9	24	12
DK	Fungi	Hygrocybe splendidissima	198	2.0	46.0	78.3	45	22
DK	Fungi	Hygrocybe subpapillata	19	5.3	47.4	73.7	11	6
DK	Fungi	Hygrocybe substrangulata	31	22.6	93.6	96.8	10	6
DK	Fungi	Hygrocybe turunda	100	6.0	63.0	77.0	18	10
DK	Fungi	Hygrocybe viola	1	0.0	0.0	0.0	1	1
DK	Fungi	Hygrocybe vitellina	82	7.3	50.0	91.5	28	18
DK	Fungi	Hygrophorus camarophyllus	2	0.0	50.0	50.0	2	2
DK	Fungi	Hygrophorus lucorum	1	0.0	100.0	100.0	1	1
DK	Fungi	Hygrophorus mesotephrus	59	3.4	27.1	35.6	18	10
DK	Fungi	Hygrophorus nemoreus	13	23.1	23.1	38.5	4	3
DK	Fungi	Hygrophorus persoonii	16	0.0	43.8	43.8	13	4
DK	Fungi	Hygrophorus poetarum	6	0.0	50.0	50.0	5	2
DK	Fungi	Hymenochaete ulmicola	2	0.0	50.0	50.0	1	1
DK	Fungi	Hyphoderma macedonicum	5	80.0	100.0	100.0	2	2
DK	Fungi	Hyphoderma medioburiense	28	39.3	53.6	64.3	22	8
DK	Fungi	Hyphoderma obtusiforme	4	0.0	50.0	50.0	2	1
DK	Fungi	Hyphodermella corrugata	8	0.0	62.5	62.5	4	2
DK	Fungi	Hypholoma ericaeoides	3	0.0	66.7	66.7	2	1
DK	Fungi	Hypholoma ericaeum	4	0.0	75.0	100.0	2	1
DK	Fungi	Hypsizygus ulmarius	18	0.0	5.6	11.1	7	2
DK	Fungi	Inocybe auricoma	1	100.0	100.0	100.0	1	0
DK	Fungi	Inocybe calamistrata	12	0.0	25.0	33.3	8	5
DK	Fungi	Inocybe cryptocystis	1	0.0	0.0	0.0	1	0
DK	Fungi	Inocybe flavella	23	17.4	47.8	65.2	13	4
DK	Fungi	Inocybe huijsmanii	7	0.0	28.6	57.1	6	3
DK	Fungi	Inocybe hystrix	4	0.0	25.0	25.0	4	3
DK	Fungi	Inocybe margaritispora	8	0.0	37.5	37.5	7	3
DK	Fungi	Inocybe quietiodor	4	0.0	25.0	25.0	2	2
DK	Fungi	Inocybe sambucina	12	8.3	8.3	8.3	2	1
DK	Fungi	Inocybe tenebrosa	9	22.2	88.9	88.9	4	3
DK	Fungi	Inocybe terrigena	2	0.0	0.0	0.0	2	0
DK	Fungi	Inonotus dryadeus	253	5.5	27.3	37.6	67	28
DK	Fungi	Inonotus hispidus	55	0.0	16.4	23.6	15	5
DK	Fungi	Inonotus ulmicola	1	0.0	0.0	0.0	1	0
DK	Fungi	Irpex lacteus	1	100.0	100.0	100.0	1	1
DK	Fungi	Ischnoderma resinosum	213	35.2	62.4	68.5	21	11
DK	Fungi	Kavinia himantia	23	65.2	87.0	87.0	4	3
DK	Fungi	Lactarius acerrimus	143	0.0	21.0	25.9	23	10
DK	Fungi	Lactarius albocarneus	46	6.5	41.3	52.2	16	8
DK	Fungi	Lactarius aquizonatus	11	0.0	0.0	90.9	1	0
DK	Fungi	Lactarius azonites	71	2.8	28.2	31.0	24	11
DK	Fungi	Lactarius decipiens	28	7.1	46.4	53.6	9	5
DK	Fungi	Lactarius evosmus	58	0.0	44.8	50.0	14	7
DK	Fungi	Lactarius hysginus	4	0.0	25.0	25.0	3	2
DK	Fungi	Lactarius lignyotus	55	0.0	61.8	61.8	8	3
DK	Fungi	Lactarius mairei	4	0.0	0.0	0.0	1	1
DK	Fungi	Lactarius mammosus	60	11.7	15.0	33.3	12	3
DK	Fungi	Lactarius musteus	57	31.6	36.8	40.4	4	2
DK	Fungi	Lactarius porninsis	30	0.0	53.3	53.3	7	2
DK	Fungi	Lactarius repraesentaneus	58	0.0	27.6	39.7	18	8
DK	Fungi	Lactarius rostratus	54	0.0	7.4	25.9	10	4
DK	Fungi	Lactarius scrobiculatus	4	0.0	50.0	50.0	3	2
DK	Fungi	Lactarius spinosulus	11	0.0	0.0	0.0	5	3
DK	Fungi	Lactarius uvidus	32	9.4	18.8	59.4	8	4
DK	Fungi	Lactarius violascens	19	0.0	52.6	52.6	7	3
DK	Fungi	Lactarius volemus	251	6.4	35.5	50.2	57	22
DK	Fungi	Lactarius zonarius	14	0.0	0.0	7.1	3	2
DK	Fungi	Lentaria byssiseda	45	2.2	55.6	95.6	8	4
DK	Fungi	Lentaria epichnoa	14	50.0	57.1	64.3	5	4
DK	Fungi	Lentinellus ursinus	91	24.2	58.2	65.9	29	14
DK	Fungi	Lentinellus vulpinus	2	0.0	0.0	0.0	1	0
DK	Fungi	Lentinus suavissimus	17	0.0	58.8	82.4	6	5
DK	Fungi	Lentinus tigrinus	3	0.0	0.0	0.0	2	1
DK	Fungi	Lepiota cingulum	10	80.0	80.0	80.0	4	3
DK	Fungi	Lepiota echinella	32	34.4	59.4	68.8	15	7
DK	Fungi	Lepiota fuscovinacea	50	22.0	44.0	48.0	16	10

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Fungi	Lepiota grangei	47	17.0	40.4	44.7	24	15
DK	Fungi	Lepiota griseovirens	44	11.4	40.9	50.0	23	13
DK	Fungi	Lepiota ignivolvata	11	9.1	27.3	45.5	8	2
DK	Fungi	Lepiota ochraceofulva	29	37.9	48.3	51.7	10	5
DK	Fungi	Lepiota poliochloodes	7	14.3	42.9	42.9	5	1
DK	Fungi	Lepiota pseudolilacea	30	0.0	60.0	63.3	16	9
DK	Fungi	Lepiota subgracilis	15	0.0	40.0	53.3	10	6
DK	Fungi	Lepiota xanthophylla	6	66.7	100.0	100.0	2	2
DK	Fungi	Leucoagaricus badhamii	17	0.0	29.4	41.2	11	6
DK	Fungi	Leucoagaricus sublittoralis	4	50.0	50.0	75.0	3	1
DK	Fungi	Leucocoprinus brebissonii	35	2.9	2.9	14.3	17	7
DK	Fungi	Leucopaxillus alboalutaceus	5	60.0	60.0	60.0	2	0
DK	Fungi	Leucopaxillus compactus	6	100.0	100.0	100.0	1	1
DK	Fungi	Lichenomphalia hudsoniana	3	0.0	66.7	66.7	2	2
DK	Fungi	Limacella glioderma	6	33.3	33.3	50.0	3	1
DK	Fungi	Lindtneria trachyspora	14	57.1	71.4	78.6	7	5
DK	Fungi	Lycoperdon mammiforme	26	7.7	30.8	30.8	11	8
DK	Fungi	Lyophyllum deliberatum	19	0.0	5.3	10.5	5	3
DK	Fungi	Lyophyllum eustygium	15	0.0	20.0	26.7	6	3
DK	Fungi	Lyophyllum hebelomoides	4	0.0	0.0	0.0	1	1
DK	Fungi	Lyophyllum leucophaeatum	14	7.1	28.6	28.6	12	2
DK	Fungi	Lyophyllum semitale	19	0.0	31.6	57.9	8	4
DK	Fungi	Melanophyllum eyrei	9	11.1	22.2	33.3	5	3
DK	Fungi	Microglossum olivaceum	70	2.9	48.6	81.4	32	18
DK	Fungi	Mycena clavata	40	12.5	47.5	60.0	22	12
DK	Fungi	Mycena concolor	7	14.3	71.4	100.0	6	5
DK	Fungi	Mycena leptophylla	32	40.6	71.9	75.0	12	7
DK	Fungi	Mycena pseudopicta	9	11.1	88.9	88.9	8	6
DK	Fungi	Nemania carbonacea	33	48.5	63.6	66.7	12	6
DK	Fungi	Nemania diffusa	22	13.6	40.9	59.1	17	9
DK	Fungi	Omphalina lilacinicolor	1	0.0	0.0	0.0	1	0
DK	Fungi	Ossicaulis lignatilis	48	12.5	52.1	60.4	19	9
DK	Fungi	Pachykytospora tuberculosa	19	89.5	94.7	94.7	2	1
DK	Fungi	Perenniporia fraxinea	48	41.7	54.2	56.3	8	3
DK	Fungi	Perenniporia medulla-panis	1	0.0	0.0	100.0	1	0
DK	Fungi	Phaeocollybia arduennensis	18	0.0	11.1	11.1	10	5
DK	Fungi	Phaeocollybia christinae	5	0.0	60.0	60.0	3	2
DK	Fungi	Phaeocollybia lugubris	3	33.3	66.7	66.7	2	2
DK	Fungi	Phaeogalera stagnina	4	0.0	50.0	75.0	4	2
DK	Fungi	Phellinus laevigatus	16	25.0	25.0	50.0	6	4
DK	Fungi	Phellodon confluens	56	7.1	26.8	33.9	12	5
DK	Fungi	Phellodon melaleucus	252	3.2	24.6	30.6	50	27
DK	Fungi	Phellodon niger	221	11.3	35.8	52.0	23	13
DK	Fungi	Phellodon tomentosus	164	3.1	18.9	23.8	24	13
DK	Fungi	Phlebia subserialis	2	0.0	0.0	0.0	1	0
DK	Fungi	Pholiota henningsii	4	0.0	50.0	100.0	2	1
DK	Fungi	Pholiota lucifera	8	0.0	0.0	12.5	3	2
DK	Fungi	Pholiota squarrosoides	12	0.0	83.3	83.3	2	2
DK	Fungi	Pholiota tuberculosa	45	17.8	44.4	55.6	30	12
DK	Fungi	Phylloporus pelletieri	60	8.3	38.3	43.3	16	10
DK	Fungi	Phyllotopsis nidulans	7	57.1	85.7	85.7	3	3
DK	Fungi	Pisolithus arrhizus	31	0.0	0.0	32.3	6	1
DK	Fungi	Pluteus atromarginatus	22	0.0	27.3	31.8	17	9
DK	Fungi	Pluteus aurantiorugosus	13	7.7	30.8	46.2	7	2
DK	Fungi	Pluteus exiguus	23	34.8	56.5	69.6	11	3
DK	Fungi	Pluteus hispidulus	38	29.0	36.8	55.3	17	11
DK	Fungi	Pluteus inquilinus	11	45.5	45.5	54.6	5	2
DK	Fungi	Pluteus insidiosus	10	20.0	50.0	80.0	7	2
DK	Fungi	Pluteus leoninus	39	18.0	51.3	84.6	18	8
DK	Fungi	Pluteus pellitus	27	3.7	29.6	33.3	14	10
DK	Fungi	Pluteus roseipes	32	0.0	37.5	100.0	1	0
DK	Fungi	Polyporus melanopus	65	24.6	55.4	61.5	20	10
DK	Fungi	Porodaedalea pini	29	17.2	37.9	44.8	10	5
DK	Fungi	Poronia punctata	14	0.0	92.9	100.0	3	0
DK	Fungi	Porotheleum fimbriatum	19	68.4	84.2	89.5	8	4
DK	Fungi	Porpoloma metapodium	39	0.0	53.9	87.2	11	3
DK	Fungi	Porpoloma spinulosum	3	0.0	0.0	0.0	2	0
DK	Fungi	Psathyrella caput-medusae	7	0.0	14.3	14.3	6	2
DK	Fungi	Psathyrella leucotephra	20	30.0	45.0	45.0	8	5

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Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Fungi	Psathyrella sphagnicola	3	0.0	66.7	100.0	2	0
DK	Fungi	Psathyrella spintrigeroides	10	50.0	70.0	70.0	6	3
DK	Fungi	Psathyrella suavissima	4	0.0	50.0	50.0	3	1
DK	Fungi	Psathyrella sylvestris	18	55.6	61.1	66.7	5	3
DK	Fungi	Pseudoclitocybe expallens	18	0.0	61.1	83.3	11	7
DK	Fungi	Pseudotomentella nigra	4	0.0	100.0	100.0	1	1
DK	Fungi	Psilocybe turficola	4	0.0	50.0	75.0	3	1
DK	Fungi	Pycnoporellus fulgens	112	11.6	47.3	54.5	13	8
DK	Fungi	Ramaria botrytis	162	3.1	30.9	38.3	30	16
DK	Fungi	Ramaria fagetorum	75	13.3	68.0	69.3	15	9
DK	Fungi	Ramaria fennica	25	0.0	56.0	56.0	8	4
DK	Fungi	Ramaria flavescens	7	14.3	71.4	71.4	3	2
DK	Fungi	Ramaria formosa	16	6.3	31.3	31.3	8	4
DK	Fungi	Ramaria krieglsteineri	9	11.1	33.3	33.3	7	4
DK	Fungi	Ramaria largentii	1	100.0	100.0	100.0	1	1
DK	Fungi	Ramaria pallida	130	4.6	43.1	45.4	23	11
DK	Fungi	Ramaria sanguinea	145	20.0	48.3	53.1	28	18
DK	Fungi	Ramaria suecica	22	22.7	45.5	45.5	8	5
DK	Fungi	Ramariopsis pulchella	18	27.8	50.0	77.8	8	3
DK	Fungi	Rhizomarasmius undatus	1	100.0	100.0	100.0	1	1
DK	Fungi	Rhodocollybia prolixa	8	12.5	0.0	25.0	7	1
DK	Fungi	Rhodocybe hirneola	7	85.7	100.0	100.0	3	2
DK	Fungi	Rhodocybe melleopallens	9	55.6	77.8	88.9	6	5
DK	Fungi	Rhodocybe nitellina	13	46.2	61.5	61.5	8	5
DK	Fungi	Rugosomyces cerinus	22	27.3	54.6	63.6	6	4
DK	Fungi	Rugosomyces chrysenteron	5	0.0	20.0	40.0	3	2
DK	Fungi	Rugosomyces ionides	51	31.4	68.6	86.3	16	10
DK	Fungi	Rugosomyces obscurissimus	44	0.0	18.2	45.5	13	3
DK	Fungi	Russula albonigra	46	8.7	43.5	45.7	12	8
DK	Fungi	Russula anthracina	44	11.4	45.5	50.0	19	12
DK	Fungi	Russula badia	3	0.0	100.0	100.0	1	1
DK	Fungi	Russula caerulea	38	0.0	52.6	55.3	16	6
DK	Fungi	Russula carpini	43	0.0	4.7	4.7	6	1
DK	Fungi	Russula decipiens	21	0.0	42.9	57.1	6	2
DK	Fungi	Russula emeticicolor	34	0.0	29.4	29.4	15	8
DK	Fungi	Russula fragrantissima	20	0.0	5.0	15.0	8	2
DK	Fungi	Russula helodes	22	9.1	59.1	63.6	9	5
DK	Fungi	Russula innocua	16	6.3	12.5	12.5	3	2
DK	Fungi	Russula integra	30	0.0	40.0	40.0	7	4
DK	Fungi	Russula laeta	97	3.1	23.7	28.9	27	9
DK	Fungi	Russula lilacea	56	5.4	21.4	28.6	13	7
DK	Fungi	Russula melliolens	56	1.8	42.9	42.9	11	5
DK	Fungi	Russula minutula	8	0.0	0.0	0.0	1	0
DK	Fungi	Russula mustelina	16	0.0	37.5	37.5	8	5
DK	Fungi	Russula pallidospora	21	4.8	9.5	23.8	3	1
DK	Fungi	Russula persicina	16	25.0	43.8	50.0	9	5
DK	Fungi	Russula puellula	21	0.0	38.1	47.6	8	4
DK	Fungi	Russula rhodopus	11	9.1	18.2	36.4	5	3
DK	Fungi	Russula roseoaurantia	51	0.0	29.4	49.0	13	7
DK	Fungi	Russula rubra	17	0.0	47.1	47.1	5	0
DK	Fungi	Russula sanguinea	66	1.5	24.2	31.8	36	16
DK	Fungi	Russula seperina	11	0.0	100.0	100.0	1	0
DK	Fungi	Russula torulosa	1	0.0	100.0	100.0	1	0
DK	Fungi	Russula turci	50	4.0	30.0	30.0	12	6
DK	Fungi	Russula zonatula	29	13.8	24.1	27.6	5	1
DK	Fungi	Russula zvarae	2	0.0	0.0	0.0	2	1
DK	Fungi	Sarcodon glaucopus	2	0.0	100.0	100.0	1	0
DK	Fungi	Sarcodon imbricatus	62	0.0	9.7	16.1	29	16
DK	Fungi	Sarcodon lepidus	15	93.3	93.3	93.3	2	2
DK	Fungi	Sarcodon scabrosus	41	2.4	41.5	58.5	7	5
DK	Fungi	Sarcodon squamosus	108	0.9	39.8	43.5	27	9
DK	Fungi	Simocybe sumptuosa	19	26.3	73.7	84.2	14	6
DK	Fungi	Spongipellis delectans	39	7.7	74.4	74.4	9	7
DK	Fungi	Squamanita paradoxa	2	0.0	0.0	100.0	1	1
DK	Fungi	Steccherinum litschaueri	4	75.0	75.0	75.0	3	1
DK	Fungi	Steccherinum robustius	7	85.7	14.3	85.7	3	1
DK	Fungi	Steccherinum subcrinale	2	50.0	100.0	100.0	2	1
DK	Fungi	Stypella dubia	15	73.3	86.7	86.7	7	5
DK	Fungi	Stypella subgelatinosa	28	53.6	60.7	64.3	13	3

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Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Fungi	Suillus placidus	21	0.0	100.0	100.0	1	1
DK	Fungi	Tomentella crinalis	35	11.4	28.6	60.0	17	10
DK	Fungi	Tomentella italica	3	0.0	66.7	100.0	2	1
DK	Fungi	Tomentella lateritia	35	71.4	88.6	94.3	12	8
DK	Fungi	Tomentella pilosa	11	36.4	36.4	45.5	7	4
DK	Fungi	Tomentella umbrinospora	15	53.3	66.7	66.7	12	5
DK	Fungi	Trametes pubescens	2	50.0	50.0	50.0	2	1
DK	Fungi	Trametes suaveolens	60	0.0	5.0	51.7	8	3
DK	Fungi	Trechispora silvae-ryae	29	58.6	69.0	82.8	7	2
DK	Fungi	Tremellodendropsis tuberosa	49	0.0	53.1	75.5	21	11
DK	Fungi	Trichoglossum walteri	17	23.5	70.6	88.2	6	3
DK	Fungi	Tricholoma apium	45	0.0	15.6	15.6	6	3
DK	Fungi	Tricholoma arvernense	115	2.6	31.3	32.2	16	8
DK	Fungi	Tricholoma aurantium	96	21.9	51.0	88.5	8	5
DK	Fungi	Tricholoma basirubens	27	14.8	37.0	40.7	10	7
DK	Fungi	Tricholoma columbetta	128	5.5	36.7	48.4	39	20
DK	Fungi	Tricholoma focale	110	0.9	31.8	38.2	21	9
DK	Fungi	Tricholoma inamoenum	22	0.0	63.6	63.6	8	5
DK	Fungi	Tricholoma matsutake	11	0.0	0.0	0.0	4	2
DK	Fungi	Tricholoma sejunctum	124	6.5	29.8	34.7	21	8
DK	Fungi	Tricholoma sudum	38	10.5	29.0	39.5	12	4
DK	Fungi	Tricholoma umbonatum	15	13.3	80.0	80.0	3	1
DK	Fungi	Tricholoma ustaloides	29	13.8	24.1	34.5	10	6
DK	Fungi	Tulostoma brumale	141	1.4	62.4	83.0	28	13
DK	Fungi	Tulostoma fimbriatum	41	0.0	75.6	95.1	8	3
DK	Fungi	Tulostoma kotlabae	5	0.0	100.0	100.0	3	3
DK	Fungi	Tulostoma melanocyclum	1	0.0	0.0	0.0	1	1
DK	Fungi	Volvariella caesiotincta	25	16.0	44.0	60.0	12	6
DK	Fungi	Volvariella hypopithys	36	8.3	19.4	25.0	26	12
DK	Fungi	Volvariella murinella	36	5.6	16.7	25.0	25	13
DK	Fungi	Volvariella surrecta	71	2.8	9.9	18.3	23	12
DK	Fungi	Xenasma pruinosum	8	87.5	100.0	100.0	3	2
DK	Fungi	Xenasma pulverulentum	17	52.9	58.8	82.4	10	7
DK	Fungi	Xerula caussei	24	58.3	70.8	70.8	8	4
DK	Fungi	Xerula longipes	17	5.9	47.1	47.1	7	4
DK	Fungi	Xylobolus frustulatus	13	23.1	100.0	100.0	4	4
DK	Lichen	Acarospora smaragdula	1	0.0	0.0	0.0	1	1
DK	Lichen	Acarospora veronensis	6	0.0	50.0	66.7	5	3
DK	Lichen	Acrocordia gemmata	5	20.0	40.0	40.0	4	2
DK	Lichen	Agonimia allobata	1	100.0	100.0	100.0	1	0
DK	Lichen	Anisomeridium biforme	5	40.0	80.0	80.0	4	3
DK	Lichen	Anisomeridium polypori	13	30.8	61.5	61.5	10	5
DK	Lichen	Arctoparmelia incurva	1	0.0	0.0	100.0	1	1
DK	Lichen	Arthonia radiata	69	21.7	47.8	62.3	38	14
DK	Lichen	Arthonia vinosa	8	50.0	62.5	75.0	6	3
DK	Lichen	Aspicilia aquatica	1	0.0	0.0	0.0	1	0
DK	Lichen	Bacidina phacodes	1	100.0	100.0	100.0	1	1
DK	Lichen	Bactrospora corticola	2	100.0	100.0	100.0	1	1
DK	Lichen	Baeomyces placophyllus	2	0.0	100.0	100.0	1	0
DK	Lichen	Caloplaca cerina	2	0.0	0.0	0.0	2	1
DK	Lichen	Caloplaca crenularia	8	12.5	25.0	25.0	8	6
DK	Lichen	Caloplaca ferruginea	1	0.0	100.0	100.0	1	0
DK	Lichen	Caloplaca flavorubescens	4	0.0	25.0	25.0	4	2
DK	Lichen	Caloplaca lucifuga	2	100.0	100.0	100.0	1	1
DK	Lichen	Caloplaca luteoalba	1	100.0	100.0	100.0	1	1
DK	Lichen	Caloplaca obscurella	4	50.0	50.0	50.0	4	2
DK	Lichen	Catillaria atomarioides	6	0.0	0.0	0.0	6	3
DK	Lichen	Cercidospora epipolytropa	3	0.0	33.3	33.3	3	2
DK	Lichen	Cetraria ericetorum	1	100.0	100.0	100.0	1	0
DK	Lichen	Cladonia bellidiflora	1	0.0	100.0	100.0	1	0
DK	Lichen	Cladonia botrytes	2	0.0	0.0	50.0	2	1
DK	Lichen	Cladonia cariosa	1	0.0	0.0	100.0	1	0
DK	Lichen	Cladonia carneola	5	80.0	100.0	100.0	1	1
DK	Lichen	Cladonia cenotea	2	0.0	100.0	100.0	2	2
DK	Lichen	Cladonia crispata	14	28.6	71.4	92.9	13	6
DK	Lichen	Cladonia cryptochlorophaea	4	0.0	25.0	50.0	3	0
DK	Lichen	Cladonia diversa	50	24.0	60.0	72.0	31	9
DK	Lichen	Cladonia floerkeana	287	17.1	49.8	68.3	104	40
DK	Lichen	Cladonia glauca	101	21.8	57.4	71.3	55	19

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Lichen	Cladonia humilis	70	8.6	28.6	48.6	46	13
DK	Lichen	Cladonia incrassata	3	33.3	33.3	100.0	3	1
DK	Lichen	Cladonia novochlorophaea	11	0.0	27.3	63.6	9	3
DK	Lichen	Cladonia parasitica	3	66.7	66.7	100.0	3	1
DK	Lichen	Cladonia phyllophora	15	33.3	60.0	86.7	9	4
DK	Lichen	Cladonia pocillum	1	100.0	100.0	100.0	1	1
DK	Lichen	Cladonia pulvinata	5	20.0	80.0	80.0	83	31
DK	Lichen	Cladonia ramulosa	159	15.1	49.1	64.2	36	16
DK	Lichen	Cladonia rangiformis	144	7.6	39.6	62.5	8	3
DK	Lichen	Cladonia rei	9	11.1	66.7	88.9	52	23
DK	Lichen	Cladonia squamosa	42	19.1	40.5	57.1	27	11
DK	Lichen	Cladonia strepsilis	3	33.3	33.3	100.0	2	1
DK	Lichen	Cladonia subcervicornis	5	40.0	80.0	100.0	5	2
DK	Lichen	Cladonia subulata	82	9.8	40.2	52.4	58	17
DK	Lichen	Cladonia sulphurina	14	7.1	78.6	92.9	8	6
DK	Lichen	Cladonia zopfii	31	9.7	41.9	74.2	22	9
DK	Lichen	Clauzadea monticola	1	0.0	100.0	100.0	1	1
DK	Lichen	Collema flaccidum	2	0.0	50.0	50.0	2	2
DK	Lichen	Collema limosum	1	0.0	0.0	100.0	1	0
DK	Lichen	Cyphelium sessile	3	66.7	100.0	100.0	2	2
DK	Lichen	Cystocoleus ebeneus	1	0.0	0.0	0.0	1	0
DK	Lichen	Dactylospora parasitica	2	100.0	100.0	100.0	2	1
DK	Lichen	Dermatocarpon luridum	1	100.0	100.0	100.0	1	1
DK	Lichen	Dibaeis baeomyces	8	0.0	100.0	100.0	2	1
DK	Lichen	Diploschistes scruposus	1	0.0	0.0	100.0	1	1
DK	Lichen	Flavocetraria cucullata	1	0.0	100.0	100.0	1	1
DK	Lichen	Flavocetraria nivalis	6	0.0	83.3	100.0	4	1
DK	Lichen	Fuscidea cyathoides	1	0.0	100.0	100.0	1	1
DK	Lichen	Gyalecta flotowii	1	0.0	100.0	100.0	1	0
DK	Lichen	Gyalecta truncigena	1	0.0	0.0	100.0	1	0
DK	Lichen	Gyalecta ulmi	1	0.0	0.0	100.0	1	0
DK	Lichen	Haematomma ochroleucum	69	10.1	33.3	44.9	38	18
DK	Lichen	Icmadophila ericetorum	2	0.0	50.0	100.0	2	0
DK	Lichen	Lecanactis abietina	342	71.9	98.5	98.8	31	19
DK	Lichen	Lecania cyrtellina	3	66.7	66.7	66.7	3	2
DK	Lichen	Lecania hyalina	1	100.0	100.0	100.0	1	1
DK	Lichen	Lecania naegelii	2	0.0	100.0	100.0	2	1
DK	Lichen	Lecanora argentata	17	35.3	76.5	82.4	13	6
DK	Lichen	Lecanora confusa	1	0.0	100.0	100.0	1	1
DK	Lichen	Lecanora glabrata	14	21.4	35.7	35.7	9	4
DK	Lichen	Lecanora intricata	12	0.0	58.3	75.0	8	3
DK	Lichen	Lecanora intumescens	9	33.3	44.4	66.7	8	3
DK	Lichen	Lecanora leptyrodes	1	0.0	100.0	100.0	1	1
DK	Lichen	Lecanora orosthea	23	0.0	17.4	21.7	17	6
DK	Lichen	Lecanora pulicaris	61	18.0	41.0	67.2	41	19
DK	Lichen	Lecanora rupicola	153	2.6	17.0	23.5	90	30
DK	Lichen	Lecanora sambuci	1	0.0	100.0	100.0	1	1
DK	Lichen	Lecanora soralifera	3	0.0	33.3	33.3	3	2
DK	Lichen	Lecanora subrugosa	2	50.0	50.0	50.0	2	0
DK	Lichen	Lecanora sulphurea	54	0.0	20.4	22.2	42	19
DK	Lichen	Lecanora symmicta	45	15.6	62.2	73.3	28	14
DK	Lichen	Lecanora varia	19	5.3	26.3	47.4	13	4
DK	Lichen	Lecidea fuscoatra	86	8.1	29.1	33.7	56	23
DK	Lichen	Leptogium gelatinosum	1	0.0	100.0	100.0	1	1
DK	Lichen	Leptogium lichenoides	1	0.0	0.0	0.0	1	1
DK	Lichen	Lichina confinis	3	0.0	66.7	66.7	3	2
DK	Lichen	Lobaria pulmonaria	147	34.7	89.1	91.2	18	12
DK	Lichen	Megalaria laureri	3	33.3	100.0	100.0	2	1
DK	Lichen	Melanohalea elegantula	15	0.0	20.0	26.7	7	3
DK	Lichen	Miriquidica deusta	7	42.9	71.4	71.4	5	3
DK	Lichen	Mycoblastus sanguinarius	1	0.0	0.0	0.0	1	0
DK	Lichen	Mycocalicium subtile	8	12.5	37.5	50.0	6	3
DK	Lichen	Nectriopsis lecanodes	2	0.0	0.0	50.0	2	1
DK	Lichen	Nephroma laevigatum	1	0.0	100.0	100.0	1	0
DK	Lichen	Normandina pulchella	1	100.0	100.0	100.0	1	1
DK	Lichen	Ochrolechia androgyna	8	50.0	87.5	87.5	6	3
DK	Lichen	Ochrolechia frigida	2	50.0	50.0	50.0	1	0
DK	Lichen	Ochrolechia microstictoides	4	75.0	75.0	75.0	3	1
DK	Lichen	Ochrolechia pallescens	2	0.0	50.0	50.0	2	1

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Lichen	Ochrolechia subviridis	8	37.5	100.0	100.0	5	4
DK	Lichen	Ochrolechia turneri	9	11.1	55.6	55.6	8	3
DK	Lichen	Opegrapha herbarum	5	20.0	100.0	100.0	4	4
DK	Lichen	Opegrapha ochrocheila	3	100.0	100.0	100.0	2	1
DK	Lichen	Opegrapha sorediifera	3	100.0	100.0	100.0	3	2
DK	Lichen	Opegrapha varia	12	50.0	66.7	75.0	10	7
DK	Lichen	Opegrapha vermicellifera	145	56.6	98.6	98.6	26	18
DK	Lichen	Opegrapha viridis	10	40.0	80.0	100.0	8	3
DK	Lichen	Opegrapha vulgata	9	44.4	66.7	88.9	8	4
DK	Lichen	Pachyphiale carneola	11	27.3	81.8	81.8	7	5
DK	Lichen	Parmeliella triptophylla	1	0.0	100.0	100.0	1	0
DK	Lichen	Parmelina tiliacea	1	0.0	100.0	100.0	1	1
DK	Lichen	Peltigera collina	3	0.0	33.3	33.3	2	1
DK	Lichen	Peltigera leucophlebia	1	100.0	100.0	100.0	1	0
DK	Lichen	Peltigera malacea	8	12.5	25.0	37.5	8	2
DK	Lichen	Peltigera neckeri	6	0.0	33.3	50.0	5	3
DK	Lichen	Peltigera polydactylon	5	20.0	60.0	60.0	5	3
DK	Lichen	Peltigera ponojensis	9	0.0	0.0	11.1	9	3
DK	Lichen	Peltigera praetextata	24	16.7	50.0	58.3	17	6
DK	Lichen	Peltigera rufescens	18	11.1	27.8	33.3	15	4
DK	Lichen	Pertusaria amara	81	14.8	50.6	59.3	44	22
DK	Lichen	Pertusaria coccodes	15	33.3	53.3	60.0	9	5
DK	Lichen	Pertusaria corallina	3	0.0	66.7	100.0	2	1
DK	Lichen	Pertusaria flavida	6	50.0	66.7	66.7	4	1
DK	Lichen	Pertusaria hemisphaerica	9	66.7	88.9	88.9	7	3
DK	Lichen	Pertusaria leioplaca	16	25.0	56.3	68.8	11	6
DK	Lichen	Pertusaria multipuncta	1	100.0	100.0	100.0	1	0
DK	Lichen	Phaeophyscia endophoenicea	1	100.0	100.0	100.0	1	1
DK	Lichen	Physcia stellaris	1	0.0	100.0	100.0	1	1
DK	Lichen	Placynthium nigrum	2	50.0	100.0	100.0	2	1
DK	Lichen	Polysporina simplex	72	2.8	11.1	18.1	54	20
DK	Lichen	Polysporina subfuscescens	28	0.0	14.3	14.3	24	12
DK	Lichen	Porina aenea	42	16.7	45.2	54.8	26	14
DK	Lichen	Porina borreri	1	0.0	100.0	100.0	1	1
DK	Lichen	Porina chlorotica	23	8.7	30.4	39.1	21	10
DK	Lichen	Porina lectissima	1	0.0	0.0	100.0	1	0
DK	Lichen	Porpidia cinereoatra	12	8.3	16.7	16.7	9	3
DK	Lichen	Porpidia crustulata	2	50.0	50.0	50.0	2	1
DK	Lichen	Porpidia macrocarpa	7	0.0	42.9	42.9	4	3
DK	Lichen	Porpidia soredizodes	69	1.5	14.5	15.9	51	19
DK	Lichen	Porpidia tuberculosa	20	0.0	20.0	25.0	16	6
DK	Lichen	Protoblastenia rupestris	6	0.0	50.0	50.0	6	3
DK	Lichen	Protoparmelia badia	4	25.0	50.0	50.0	3	3
DK	Lichen	Protoparmeliopsis achariana	1	0.0	100.0	100.0	1	0
DK	Lichen	Protoparmeliopsis macrocyclos	7	0.0	57.1	57.1	4	3
DK	Lichen	Pseudosagedia borreri	2	0.0	0.0	0.0	2	2
DK	Lichen	Psilolechia lucida	35	0.0	25.7	34.3	27	11
DK	Lichen	Punctelia subrudecta	12	0.0	8.3	50.0	6	2
DK	Lichen	Pycnothelia papillaria	4	0.0	100.0	100.0	2	1
DK	Lichen	Pyrenula chlorospila	9	66.7	77.8	77.8	5	2
DK	Lichen	Pyrenula nitida	387	44.4	96.1	97.2	44	29
DK	Lichen	Pyrenula nitidella	2	100.0	100.0	100.0	2	2
DK	Lichen	Pyrrhospora quernea	20	30.0	55.0	65.0	12	6
DK	Lichen	Ramalina calicaris	1	0.0	100.0	100.0	1	1
DK	Lichen	Ramalina pollinaria	2	0.0	100.0	100.0	1	0
DK	Lichen	Ramonia chrysophaea	1	0.0	100.0	100.0	1	1
DK	Lichen	Rhaphidicyrtis trichosporella	2	100.0	100.0	100.0	2	1
DK	Lichen	Rimularia furvella	3	0.0	33.3	33.3	3	0
DK	Lichen	Rimularia insularis	2	0.0	0.0	0.0	2	1
DK	Lichen	Ropalospora viridis	3	100.0	100.0	100.0	3	2
DK	Lichen	Sclerophora peronella	1	100.0	100.0	100.0	1	0
DK	Lichen	Sphinctrina turbinata	2	0.0	100.0	100.0	1	1
DK	Lichen	Staurothele areolata	1	0.0	100.0	100.0	1	0
DK	Lichen	Stereocaulon condensatum	2	50.0	100.0	100.0	2	2
DK	Lichen	Stereocaulon dactylophyllum	8	0.0	62.5	62.5	7	4
DK	Lichen	Stereocaulon evolutum	8	0.0	25.0	50.0	7	3
DK	Lichen	Stereocaulon pileatum	3	0.0	0.0	0.0	1	0
DK	Lichen	Stereocaulon saxatile	13	30.8	76.9	84.6	8	5
DK	Lichen	Stereocaulon vesuvianum	11	0.0	18.2	27.3	9	3

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Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Lichen	Thelopsis rubella	1	100.0	100.0	100.0	1	1
DK	Lichen	Thelotrema lepadinum	821	54.1	97.9	98.3	36	18
DK	Lichen	Trapelia obtegens	1	0.0	100.0	100.0	1	1
DK	Lichen	Trapeliopsis gelatinosa	4	50.0	75.0	100.0	4	2
DK	Lichen	Umbilicaria deusta	12	0.0	50.0	83.3	7	4
DK	Lichen	Umbilicaria polyphylla	31	6.5	32.3	51.6	18	9
DK	Lichen	Usnea filipendula	22	9.1	40.9	54.6	18	8
DK	Lichen	Usnea genus	2	0.0	100.0	100.0	1	0
DK	Lichen	Usnea hirta	23	17.4	47.8	73.9	19	11
DK	Lichen	Usnea subfloridana	35	14.3	37.1	48.6	23	11
DK	Lichen	Verrucaria mucosa	1	0.0	100.0	100.0	1	0
DK	Lichen	Xanthomendoza poeltii	2	0.0	50.0	100.0	2	2
DK	Lichen	Xanthoparmelia conspersa	63	6.4	33.3	52.4	35	16
DK	Lichen	Xanthoparmelia loxodes	44	2.3	31.8	38.6	31	14
DK	Lichen	Xanthoparmelia pulla	12	0.0	41.7	66.7	8	3
DK	Lichen	Xanthoparmelia somloensis	14	0.0	28.6	42.9	12	5
DK	Lichen	Xanthoparmelia tinctina	11	0.0	27.3	36.4	10	5
DK	Lichen	Xanthoparmelia verruculifera	47	2.1	23.4	29.8	36	13
DK	Lichen	Zamenhofia hibernica	1	0.0	100.0	100.0	1	1
DK	Plant	Alisma gramineum	2	0.0	100.0	100.0	1	0
DK	Plant	Alisma lanceolatum	37	0.0	43.2	62.2	25	13
DK	Plant	Althaea officinalis	151	0.0	79.5	88.7	28	10
DK	Plant	Anacamptis pyramidalis	90	81.1	81.1	84.4	5	4
DK	Plant	Anemone vernalis	96	25.0	58.3	75.0	8	4
DK	Plant	Anthericum liliago	32	0.0	15.6	59.4	8	4
DK	Plant	Anthyllis vulneraria ssp. danica	4	0.0	100.0	100.0	1	1
DK	Plant	Asplenium scolopendrium	43	0.0	72.1	74.4	11	5
DK	Plant	Botrychium matricariifolium	30	3.3	30.0	90.0	7	2
DK	Plant	Botrychium multifidum	175	0.0	100.0	100.0	6	3
DK	Plant	Bromus racemosus	51	11.8	35.3	72.6	33	15
DK	Plant	Calamagrostis stricta	221	4.5	61.5	95.0	65	25
DK	Plant	Carex buxbaumii	24	0.0	41.7	91.7	3	2
DK	Plant	Carex chordorrhiza	35	22.9	62.9	94.3	12	7
DK	Plant	Carex ligerica	91	0.0	64.8	85.7	14	9
DK	Plant	Carex maritima	3	0.0	0.0	100.0	1	0
DK	Plant	Carex paleacea	2	50.0	50.0	50.0	2	0
DK	Plant	Cephalanthera longifolia	60	40.0	50.0	58.3	11	5
DK	Plant	Cephalanthera rubra	91	87.9	98.9	98.9	3	2
DK	Plant	Cerastium subtetrandrum	10	0.0	70.0	100.0	3	1
DK	Plant	Corrigiola litoralis	31	0.0	90.3	90.3	3	2
DK	Plant	Crassula aquatica	2	0.0	100.0	100.0	2	1
DK	Plant	Crepis praemorsa	52	7.7	69.2	76.9	7	6
DK	Plant	Cuscuta epithymum ssp. epithymum	123	0.8	51.2	82.1	28	9
DK	Plant	Cyperus fuscus	20	0.0	55.0	100.0	3	2
DK	Plant	Dactylorhiza incarnata ssp. lobelii	34	0.0	76.5	79.4	2	2
DK	Plant	Dactylorhiza incarnata ssp. ochroleuca	37	2.7	78.4	83.8	5	4
DK	Plant	Dactylorhiza majalis ssp. integrata	147	0.0	33.3	56.5	21	4
DK	Plant	Dactylorhiza sambucina	127	2.4	94.5	96.9	8	7
DK	Plant	Dianthus armeria	92	0.0	53.3	77.2	29	10
DK	Plant	Draba incana	72	6.9	70.8	80.6	8	5
DK	Plant	Draba muralis	3	0.0	100.0	100.0	1	0
DK	Plant	Drosera anglica	216	47.2	83.8	97.7	40	17
DK	Plant	Eleocharis parvula	9	0.0	100.0	100.0	7	4
DK	Plant	Epipactis atrorubens	59	79.7	84.8	91.5	3	1
DK	Plant	Epipactis leptochila	51	43.1	54.9	54.9	8	4
DK	Plant	Epipogium aphyllum	2	100.0	100.0	100.0	1	0
DK	Plant	Eriophorum gracile	37	0.0	81.1	94.6	19	11
DK	Plant	Euphorbia palustris	7	0.0	100.0	100.0	1	0
DK	Plant	Euphrasia arctica ssp. minor	57	42.1	100.0	100.0	4	2
DK	Plant	Euphrasia dunensis	22	0.0	59.1	95.5	6	4
DK	Plant	Euphrasia rostkoviana ssp. rostkoviana	2	0.0	100.0	100.0	2	2
DK	Plant	Festuca polesica	26	0.0	46.2	96.2	7	3
DK	Plant	Galium valdepilosum	8	0.0	62.5	75.0	4	3
DK	Plant	Gentianella campestris	107	15.0	49.5	89.7	25	14
DK	Plant	Gymnadenia conopsea	76	0.0	63.2	68.4	7	6
DK	Plant	Herminium monorchis	121	5.0	80.2	89.3	13	10
DK	Plant	Hypochoeris maculata	621	1.5	60.2	89.1	111	46
DK	Plant	Illecebrum verticillatum	42	0.0	90.5	97.6	6	3
DK	Plant	Juncus alpinoarticulatus ssp. alpinoarticula	16	6.3	25.0	87.5	8	3

Suppl. Materials, Table A3. Danish records 1991-2015 of 1371 threatened species; Erik Buchwald.			Presence records				Grid cells 10 x 10 km	
Threat listing	Taxon_group	Species name	Total records	% in iucn1-2	% in sacs	% in iucn1-4	Total	sac-set 172 cells
DK	Plant	Juncus alpinoarticulatus ssp. nodulosus	61	8.2	96.7	100.0	11	5
DK	Plant	Laserpitium latifolium	21	4.8	57.1	76.2	3	2
DK	Plant	Lathyrus sphaericus	92	7.6	84.8	92.4	8	7
DK	Plant	Limosella aquatica	42	0.0	38.1	85.7	9	5
DK	Plant	Melampyrum cristatum	100	45.0	49.0	75.0	16	10
DK	Plant	Melampyrum nemorosum	151	39.7	37.8	59.6	20	10
DK	Plant	Mertensia maritima	2	0.0	100.0	100.0	1	1
DK	Plant	Neotinea ustulata	59	0.0	62.7	66.1	9	7
DK	Plant	Ophrys insectifera	90	84.4	92.2	92.2	1	0
DK	Plant	Orobanche purpurea	37	0.0	0.0	8.1	3	1
DK	Plant	Orobanche reticulata	18	0.0	0.0	27.8	2	0
DK	Plant	Peucedanum oreoselinum	29	0.0	24.1	51.7	10	5
DK	Plant	Pilosella cymosa	15	0.0	26.7	53.3	7	3
DK	Plant	Platanthera bifolia ssp. latiflora	53	11.3	28.3	28.3	5	1
DK	Plant	Poa supina	51	2.0	60.8	84.3	28	8
DK	Plant	Polygonum oxyspermum	1	0.0	100.0	100.0	1	1
DK	Plant	Polygonum raii ssp. norvegicum	11	63.6	81.8	81.8	4	2
DK	Plant	Polystichum aculeatum	17	0.0	70.6	88.2	4	1
DK	Plant	Potamogeton coloratus	68	0.0	57.4	94.1	21	12
DK	Plant	Potamogeton compressus	92	0.0	43.5	78.3	32	10
DK	Plant	Potamogeton filiformis	93	0.0	48.4	91.4	32	17
DK	Plant	Potamogeton friesii	91	0.0	58.2	95.6	51	22
DK	Plant	Potamogeton rutilus	11	0.0	72.7	100.0	6	4
DK	Plant	Potamogeton trichoides	52	0.0	0.0	50.0	14	3
DK	Plant	Potentilla sordida	3	0.0	33.3	66.7	3	1
DK	Plant	Prunella grandiflora	51	0.0	60.8	68.6	7	4
DK	Plant	Pseudorchis albida	8	0.0	87.5	100.0	5	3
DK	Plant	Pulmonaria angustifolia	33	0.0	48.5	48.5	1	1
DK	Plant	Pulmonaria officinalis	19	5.3	5.3	15.8	12	5
DK	Plant	Ranunculus polyanthemos ssp. polyanther	172	0.0	91.9	96.5	20	5
DK	Plant	Rhododendron tomentosum	10	0.0	60.0	90.0	5	2
DK	Plant	Rosa elliptica ssp. inodora	80	1.3	23.8	66.3	36	14
DK	Plant	Rosa tomentosa	22	31.8	50.0	59.1	12	6
DK	Plant	Sagina subulata	94	18.1	54.3	92.6	28	14
DK	Plant	Salix repens ssp. rosmarinifolia	9	0.0	0.0	77.8	8	2
DK	Plant	Scabiosa canescens	86	0.0	77.9	84.9	8	5
DK	Plant	Scheuchzeria palustris	141	13.5	60.3	94.3	24	12
DK	Plant	Schoenus ferrugineus	107	10.3	86.9	93.5	26	17
DK	Plant	Schoenus nigricans	136	16.2	89.7	97.1	31	21
DK	Plant	Scutellaria hastifolia	1	0.0	100.0	100.0	1	1
DK	Plant	Sedum sexangulare	29	0.0	13.8	37.9	20	6
DK	Plant	Selaginella selaginoides	51	0.0	82.4	98.0	12	9
DK	Plant	Selinum dubium	57	0.0	59.7	93.0	3	1
DK	Plant	Senecio erucifolius	37	0.0	75.7	81.1	6	3
DK	Plant	Sorbus hybrida	36	2.8	22.2	41.7	24	9
DK	Plant	Spergula morisonii	52	26.9	55.8	76.9	13	7
DK	Plant	Stachys officinalis	8	0.0	12.5	37.5	5	1
DK	Plant	Stellaria crassifolia	96	2.1	50.0	91.7	48	16
DK	Plant	Subularia aquatica	4	0.0	75.0	100.0	2	1
DK	Plant	Tephroseris integrifolia	107	5.6	56.1	76.6	14	7
DK	Plant	Tetragonolobus maritimus	322	0.0	20.2	71.4	19	5
DK	Plant	Trichophorum alpinum	57	0.0	57.9	100.0	8	5
DK	Plant	Ulmus laevis	43	2.3	14.0	32.6	15	7
DK	Plant	Utricularia ochroleuca	38	5.3	29.0	100.0	13	4
DK	Plant	Veronica verna	80	2.5	30.0	56.3	46	20
DK	Plant	Vicia orobus	135	3.7	23.0	61.5	38	12
DK	Plant	Viola epipsila	34	8.8	61.8	82.4	9	5
DK	Plant	Viola mirabilis	87	62.1	66.7	82.8	11	3
DK	Plant	Viola persicifolia	176	1.7	59.7	96.0	27	11
DK	Plant	Viola uliginosa	19	0.0	89.5	100.0	5	2

CHAPTER 2

Marxan with Zones applied to prioritize management for threatened forest species in Denmark to improve reaching 2020 biodiversity targets

Erik Buchwald & Jacob Heilmann-Clausen

(In preparation for PLOS ONE)

Previous page: Red deer in front of blooming Tephroseris palustris (photo by Erik Buchwald)

Research article for PLOS ONE

Marxan with Zones applied to prioritize management for threatened forest species in Denmark to improve reaching 2020 biodiversity targets.

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Abstract

In 2016 the Danish government decided to expand the area of forest protected for biodiversity from 11,700 to 28,300 hectares (from 1.9 to 4.5% of Danish forest area) and to base the designations on scientific recommendations involving systematic conservation planning. The decision was part of a "Nature Package" to help stop the decline in biodiversity and thus better reach national, European Union (EU) and United Nations biodiversity targets for 2020. The main part of new protected areas shall be placed in State owned forests with 10,000 hectares of new minimum-intervention reserves and 3,300 hectares of other protection types. As an input to the selection of new forest reserves we used *Marxan with Zones* to optimize cost-effective coverage of threatened biodiversity, using presence data 1991-2015 for 626 forest species threatened at global, EU or national level. The species represented three biological kingdoms and presences were extracted from data sources comprising a total of 22 million species records. Four Marxan zones were defined to represent different protection regimes with various cost assumptions: 1) Normal, 2) Conifer woods with extra protection, 3) Active protection of semi-open deciduous woods and 4) Untouched (minimum-intervention) deciduous woods. Targets were set to at least 3 or 5 representations in zones matching ecological preferences for each species, determined from literature and expert consultation. 26 scenarios were run to inspect sensitivity to input assumptions varying 1) cost as area or money, 2) cost of zone 2 and 3 compared to normal, 3) exclusion of conifer affiliated species or of species not in decline, and finally 4) locking already fully protected forests a priori to the relevant zone 4. In addition, three control scenarios were run to test effects of including poorly known species and to evaluate the potential cost reductions achieved by working with protection zones. Success rate for scenarios was assessed as 1) cost (net income foregone) and 2) target achievement for 304 threatened species in decline and therefore top priority. Results showed that target achievement varied from 199 to 262 of the 304 threatened species in decline, while cost varied from 25.5 to 68.7% of State Forest annual net income from wood harvest. It was impossible to reach targets for all species in any of the multizone scenarios, primarily because many forests were home to species with opposing

ecological preferences. The zone designation for each forest was primarily influenced by the biological input data, i.e. 450 of the 670 forests known to harbor threatened species were systematically placed in the same zone regardless of scenario assumptions (375 in zone 1, 0 in zone 2, 55 in zone 3, and 20 in zone 4). An ensuing process of designation looked into finer geographical scales to refine protection schemes for different parts of especially the larger forests in order to further enhance target achievement. *Marxan with zones* proved to be very effective and is highly recommended for solving this type of conservation problem.

Introduction

Decline of global biodiversity including extinction of threatened species is a pressing issue, which has been addressed widely in the literature (e.g. Dirzo et al. 2014; Newbold et al. 2015; Pimm et al. 2014; Steffen et al. 2015) and in political agreements of which the United Nations (UN) Convention on Biological Diversity (CBD) 1992 and its follow-up decisions are of major importance (Venter et al. 2014, 2017; Watson et al. 2016). The COP 10 meeting (UN-CBD conference of the parties) at Nagoya 2010 adopted a "Strategic Plan for Biodiversity 2011-2020" with the mission to "take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planets variety of life, and contributing to human well-being, and poverty eradication" (CBD 2010).

National follow-up of the 20 so-called Aichi targets listed in the plan is essential. For Denmark much of this is aligned with initiatives of the European Union (EU) – especially implementation of the Birds- and Habitats Directives including the Natura 2000 program. This paper describes one of the efforts done in Denmark to help reach the targets and mission. It focusses on forest species and Aichi target 12: "By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained".

Danish government decided in May 2016 to expand the area of woodland protected for biodiversity from 11,700 to 28,300 hectares (from 1.9 to 4.5% of Danish forest area). The main part of new protected areas should be placed in State owned forests, with 10,000 hectares of new minimum-intervention reserves and 3,300 hectares of other protection types (Anon. 2016). Designations were to be based on scientific recommendations and to follow-up on the forest reserves designated in the 1990'ies based on the 1992 "Strategy for natural forests and other forest types of high conservation value in Denmark" (Anon. 1994). Woodlands covered 624,782 ha of Denmark in 2015, or 14.5% of the land area with 50/50 proportion of conifers and deciduous trees (Nord-Larsen et al. 2016).

Science recommends the use of systematic conservation planning (SCP) for ensuring cost-effective biodiversity protection (Margules & Pressey 2000; Moilanen et al. 2009;Venter et al. 2014, 2017; Watson et al. 2016). SCP has been developed over the past few decades in order to provide best possible guidance to decide where and how to efficiently achieve conservation goals (Beyer et al. 2016; Kukkala & Moilanen 2013; Moilanen et al. 2009).

Numerous studies using systematic conservation planning have been published (Kukkala & Moilanen 2013) but only a minority have been applied in reality (Knight et al. 2008). One of several reasons for this implementation gap is that reality is quite complex compared to theoretical model studies and involves many political and socio-economic issues and constraints. An important aspect in this context is that many planning studies only discern between "protected" and "unprotected" in the planning algorithms, which in many cases is too simplistic and may overestimate the economic costs of conservation (Watts et al. 2009; Wilson et al. 2010). Wilson et al. (2010) found that accounting only for the contribution of protected areas could overestimate the required expenditure by 15 times, and the area requiring strict protection by almost 50 times.

Refining "protection" to different categories or management "zones" relevant to the ecological requirements of different threatened species is thus an interesting solution, since some species may actually require less than strict protection (e.g. Bernes et al. 2015; Brunet et al. 2010; Lindenmayer & Franklin 2002; Lundström et al. 2016; Peterken 1996). In strongly human-influenced landscapes like Europe, pristine nature is almost lacking and biodiversity is mainly associated with semi-natural habitats with a stronger or weaker cultural impact. This is also true for forest biodiversity that survives in fragmented forest landscapes heavily influenced by modern forest management, and lacking natural dynamics and old-growth structures (Burrascano et al. 2013; Christensen & Emborg 1996). In many landscapes, the largest biodiversity values are found in landscapes with legacies from historical land-use types, e.g. pollarding, coppicing or forest grazing (Lindenmayer & Franklin 2002; Peterken 1996). The most suitable means to protect these values are debated (e.g. Götmark 2013; Vera 2000), with recommendations spanning from continuation or reestablishment of traditional management systems like wood pasture or coppice (e.g. Peterken 1996; Tybirk & Strandberg 1999) to non-intervention (Petersen et al. 2016a). These different perspectives on forest conservation reflect differences in conservation baselines: Focus on traditional management types are linked to a historical perspective on nature, appreciating habitat continuity and local species pools as most important (Lindenmayer & Franklin 2002). Focus on non-intervention on the other hand builds on natural dynamics as the trademark of nature, and appreciates species turnover as a natural response to these dynamics, with a risk of local species loss due to unintended vegetation dynamics especially if natural grazing is missing (Götmark 2013; Nilsson 2009; Vera 2000).

The risk of species loss due to minimum or non-intervention is most evident for species associated with the more open parts of the forest - open habitat continuum (Lindhe et al. 2005; Tybirk & Strandberg 1999; Vera 2000). The reasons for this can be found in a combination of landscape history and present pressures: The species communities of Europe including Denmark have co-evolved during millennia in non-fragmented primeval landscapes with a suite of large animals, that gradually went functionally or totally extinct during the last thousands of years (Andersson & Appelqvist 1990; Dirzo et al. 2014; Nielsen 2009; Owen-Smith 1992; Vera 2000). More recently, the Danish and other NW European forest landscapes have changed dramatically over the last 200 years from a human-induced nutrient-poor and over-exploited situation with relatively open and mainly grazed woodlands (Odgaard 1994; Timmermann et al. 2015; Tybirk & Strandberg 1999; Vandekerkhove et al. 2012) into an air-pollution induced nutrient- and CO_2-enriched situation, usually without grazing. This has generally led to unnaturally high, dense and lush vegetation (Kahle 2008; Timmermann et al. 2015; Tybirk & Strandberg 1999). Furthermore forestry has changed most Danish woodlands into mosaics of biologically young, even-aged stands with a high percentage of monocultures and non-native conifers (Christensen & Emborg 1996; Feilberg 2004; Nord-Larsen et al. 2016) and with only minor proportions of more natural forest and open habitats. If simply left to succession such woodlands will keep their homogenous stand character for many decades while growing darker and denser, and will thus be unlikely to provide suitable habitats for most threatened species in the short- to medium term (e.g. Lindhe et al. 2005; Nilsson 2009; Tybirk & Strandberg 1999; Vera 2000). A range of other threats like climate change, isolation, invasive species, and extinction debts may also require some level of action, if species losses are to be avoided (Geldmann et al. 2014; Joppa et al. 2016; Timmermann et al. 2015; Virkkala et al. 2013; Wind & Pihl 2010).

To counteract negative effects of regrowth, eutrophication and darkening and to speed up the formation of old growth structures some experts argue that active restoration to enhance e.g. old-growth structures can be combined with non-traditional or close-to-nature forestry to protect biodiversity, potentially in a more cost-effective way than non-intervention (e.g. Brunet et al. 2010; Götmark 2013; Lindenmayer & Franklin 2002; Peterken 1996).

In this study we applied systematic conservation tools as part of the previously mentioned governmentally decided effort targeting biodiversity conservation in the Danish State Forests, which is planned to be implemented during the coming decade (Naturstyrelsen 2018). Compared to previous reports on systematic conservation planning targeting forest biodiversity in Denmark (Petersen et al. 2016a,b) we worked with taxa across three biological kingdoms, involving all terrestrial and amphibious species threatened at national or international level, and with a narrow focus only targeting State Forests. Further, we worked with quantitative species targets and a zonation approach differentiating four levels of protection, as a tool to reduce costs for protecting threatened species that are not benefitting from non-intervention (Nilsson 2009). A number of scenarios varying costs associated with intermediate protection zones were run to handle economic uncertainty, and similar evaluation was done for different levels of target, included species groups and previous protection.

It would have been optimal to analyze private and State forests together, and this has been done by Petersen et al. (2016b) who analyzed priority forest areas countrywide for Denmark at 10 km grid cell scale. For private forest owners interested in biodiversity protection the Danish government has set up a subsidy program which can guide subsidies to the most relevant forests based on Petersen et al. (op.cit.). The present study uses more detailed input data available for State Forests but not available for private forests.

In the rest of this paper the term *forest* is used as a description of State Forest property polygons including other habitats than woods, while the terms *woods* and *woodland* are used in the meaning of areas with >10% tree cover (FAO forest definition). Woods in Denmark generally have more than 50% tree cover (crown projection) and mostly 80-90%.

Material and methods

Several available methods and software systems for Systematic Conservation Planning were screened including Zonation, C-Plan, Marxan and integer programming methods (Moilanen et al. 2009). This resulted in the choice of Zonae Cogito (Segan et al. 2011) incorporating Marxan with Zones (Watts et al. 2009) as analysis platform, due to 1) their good documentation, 2) widespread use, 3) ability to work efficiently with several different types of protection / management at the same time (zones), 4) ability to simultaneously solve the planning problem for many hundred species distributed at many hundred different sites and 5) incorporation with GIS to support an iterative interactive planning process (Segan et al. 2011; Watts et al. 2008a; Wilson et al. 2010). In this paper all further references to Marxan deal with Marxan With Zones.

The problem to be solved in this study was of the "minimum-set" type (Possingham et al. 2006) to meet quantitative conservation objectives as cheaply as possible by optimizing which sites should be selected for protection using a complementarity approach.

Data

Danish State Forest data (status 2016) were supplied by The Nature Agency of The Ministry of Environment & Food of Denmark and covered 202,402 ha (4.7% of Danish land surface). The area was composed of 976 administrative polygons varying from less than 0.1ha up to 6,399 ha in size, and included lakes, heaths and other habitats besides woodland. Woods covered 105,919 ha

(52.3%) of which 41% were deciduous and 59% conifer dominated. For each polygon economic data in the form of annual potential net income from deciduous and conifer wood harvest was provided by The Nature Agency, with a note that the figures were model-based using 2016 price and expense levels. The modelled values do not necessarily correspond to reality, but were considered to be fine for comparison of relative values and for estimating annual net income loss if the woodland was to be protected.

For 18 polygons with negative net income the cost was changed to zero because the negative cost values were small and would probably not be generally implemented in real life. Another 327 polygons had net income at zero being already totally protected woods or other biotopes with no relevant wood production e.g. lakes with bordering trees.

Study species (N=1,932) were delimited as being terrestrial or amphibious species known from Denmark, and being globally or nationally red-listed (IUCN 2015; Wind & Pihl 2010) in the high threat categories (RE, CR, EN, VU), plus birds listed on annex I of the EU Birds Directive (EU 1979) and species listed on annexes II, IV or V of the EU Habitats Directive (EU 1992). These species are henceforth noted as threatened. Taxonomy and naming was updated to match the standard species checklist of Denmark maintained by the Danish Biodiversity Information Facility (DANBIF 2016).

Study species were placed in two priority classes A or B (Table 1) based on the geographical scope of threat combined with trend information about populations (declining or not) in red lists (IUCN 2015; Nieto & Alexander 2010; Wind & Pihl 2010) and in EU reports on Natura 2000 species (EIONET 2013a, 2013b). Globally threatened species were all taken as first priority (A), while species threatened at EU and national level were only taken as priority A if they were reported as declining in Denmark.

In total about 22 million available species records were retrieved for the 1,932 study species from a number of sources (S1 Table). Occurrences were extracted from the study period 1991-2015, quality-checked and referred to localities yielding detailed occurrence data (N= 267,438) for 1,378 species. The resulting data-set was uploaded to GBIF (Buchwald 2018a). For 554 study species no occurrences were found in the available records. These comprised 231 regionally extinct (RE) species not found or refound in the study period 1991-2015 plus 323 species not extinct according to the Danish red list, but missing records in the available data sources. These missing species are mostly lichens (*Ascomycetes*), some families of small beetles (*Coleoptera*) and twirler moths (*Gelechiidae*) where the relevant specialists have not made records digitally available, but have provided data to the redlisting process.

Study species were defined as either obligate forest, facultative forest or non-forest species, and as obligately or facultatively associated with coniferous or deciduous trees, based on previous work on the habitats of Danish species (Petersen et al. 2016a,b). Species not included in Petersen et al. (2016b) were referred to habitats using the same methodology, i.e. using data on detailed biotopes of each species recorded in the Danish Red list Database (Wind & Pihl 2010) supplemented by expert consultation.

Species only associated with non woodland biotopes were scored as non-forest species, species with only woodland biotopes as obligate forest species, and species with both woodland and openland biotopes as facultative forest species. Facultative forest species thus included species found both in fully open biotopes, e.g. heaths, moors or grasslands, and in woodland biotopes like glades, forest rims or forest interior (Table 1 & 3). Non-forest study species were excluded from the present study, but were analyzed for further protection in another sub-project (Buchwald 2018b).

Species were noted as saproxylic (involved in or dependent on wood decay) if they were included as facultatively or obligately saproxylic in any of the available lists of saproxylic species relevant for Denmark (Alexander 2002; Köhler 2000; Nieto & Alexander 2010; Stokland & Meyke 2008; Wind & Pihl 2010). In total 156 species (24.9%) of fungi (n=105), insects (n=50) and Pseudoscorpions (n=1) were noted as saproxylic. Threats and more specific ecological requirements (e.g. soil or climate affinities) were also noted for each species, based on the detailed literature and expert based information in the Danish Red list Database (Wind & Pihl 2010).

For a few species with missing or insufficient information supplementary species-specific literature was consulted. Species experts were finally consulted to quality assure critical taxon groups not well-known to the authors.

Table 1. Status, population trend and overall habitat for the 1066 study species recorded in State Forests.

Priority	**Scope of threat**	**Decline reported?**	**Forest species (N)**	**Non-forest species (N)**	**Total (N)**
A	Globally threatened (IUCN red list level CR, EN or VU)	Yes or no	3	6	9
A	EU listed in annex 1of the Birds- or annex II, IV or V of the Habitats Directive	Yes	12	30	42
A	Danish Red list (RE, CR, EN or VU)	Yes	290	276	566
B	Danish Red list (RE, CR, EN or VU) or EU species of the above-mentioned annexes.	No	321	128	449
Total			626	440	1066

Using ArcView GIS the species occurrences were referred to the above-mentioned 976 State Forest polygons. These forests had documented occurrence of 1,066 (77.4%) of the 1,378 threatened species which had records from Denmark 1991-2015 comprising 626 forest species and 440 non-forest species (Fig 1a,b).

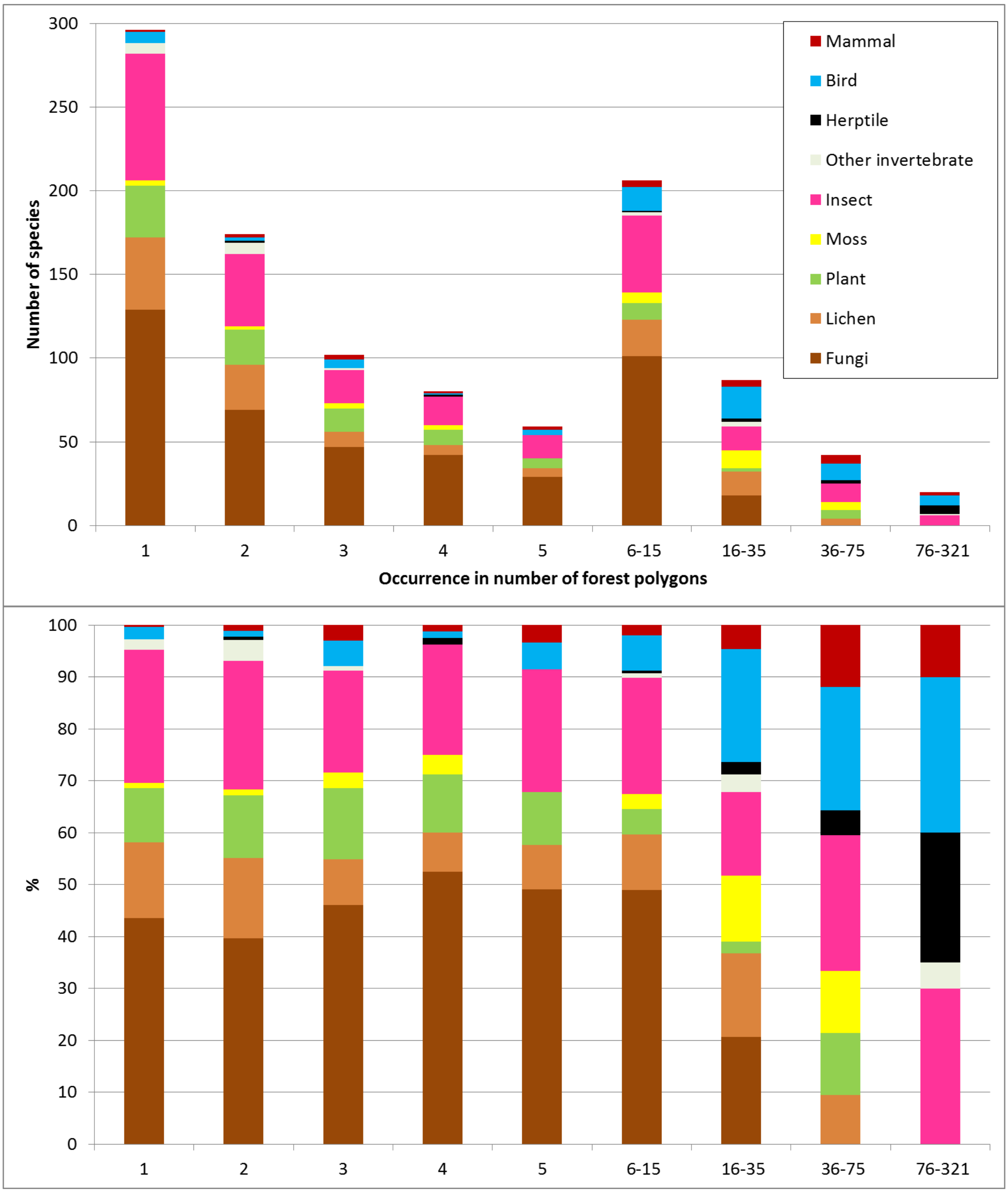

Fig 1a,b. Distribution by taxon group of the 1066 threatened species found in the 976 State Forest polygons: a) absolute species numbers, b) percentages.

Analysis methods

Four zones were defined in Marxan with Zones (Watts et al. 2009) to describe in broad terms different categories of forest protection which were possible to relate to the habitat requirements of species and to potential costs of protection (adjusted on the basis of Anon. 1994; Boch et al. 2013; Buchwald 2005; Götmark 2013; Peterken 1996): 1) State Forest with normal protection level including wood production and harvest, 2) Conifer woodland with extra species protection efforts, 3) Actively protected deciduous woodland, and 4) Minimum-intervention deciduous woodland (Table 2).

Zone 1 reflects the existing management rules for all Danish State Forests which include a number of protective biodiversity measures - most importantly enhancement of natural hydrology and deadwood, no clear cuts, and protection of a minimum of 5 trees per hectare to reach natural old-age and eventual natural death and decay.

Zone 2 was defined as woodland where extra protection is needed for threatened species dependent on conifers. All coniferous forests in Denmark derive from plantations since 1750 because natural stands of Scots pine (*Pinus sylvestris*) were exterminated in the preceding centuries. As a consequence no genuine old-growth conifer forests exist in Denmark, and most threatened species associated with conifers depend on planted conifers or on early succession stages on very poor soils (e.g. Flensted et al. 2016), that may not benefit from non-intervention.

Zone 3 was targeted at deciduous forest species with high light requirements, including need for open biotopes or open-grown trees (Lindhe et al. 2005; Nilsson 2009), and defined by less strict protection than zone 4, but involving active conservation management to create or maintain wood-pasture, meadows, glades, old veteran oaks, other specific host tree species or sunlit deadwood by means of selective cutting, grazing, coppicing or other tools. Cost levels of zone 3 were assessed to be variable depending on type and intensity of conservation measures and amount of restrictions necessary on wood harvesting. This was reflected in applying three levels of potential costs in the analysis.

Finally, zone 4 was defined as minimum-intervention deciduous woods.

Table 2. The four zones chosen and different levels of cost assessed.

Zone	Short name	Description	Cost
1	Normal	No extra protection (available zone)	0
2	Conifer	Woods given extra protection for species needing conifers	10 or 25%
3	Active	Active conservation management in deciduous woods	50, 75 or 100%
4	Untouched	Minimum-intervention deciduous woods	100%

Forest species were split into eight groups (Table 3) related to the four Marxan zones, based on habitat preferences noted for each species. The split into groups was done based on the abovementioned species data regarding preferences for a) deadwood habitats (saproxylic species), b) open or shaded habitats (light demand), c) conifers versus deciduous trees and d) long untouched woodland habitats. Because all study species are threatened, zone 1 (Normal) was not assessed as suitable as preference for any species.

Species with narrow preferences were referred narrowly to one zone, while species with less strict requirements were referred to combinations of two zones. The species information used for referring each of the 626 forest species to the Marxan zones is listed in S2 Table.

Table 3. Characteristics of species groups and their inferred preferences for the four defined Marxan zones. Species with facultative or obligate preference for conifers were excluded from group 1-5.

Group	N	Group name	Basic zone(s)	Habitat preferences / requirements / associations
1	38	Open saproxylic	3+4	Saproxylic species associated with deciduous trees found in open habitats but also with woodland habitats.
2	174	Open woodland	3	Non-saproxylic species associated with open habitats but also with deciduous woodland habitats.
3	102	Woodland saproxylic	4	Saproxylic species of deciduous trees associated only with woodland habitats and not with open habitats.
4	55	Untouched deciduous	4	Non-saproxylic species associated with non-intervention deciduous woods, but not with open habitats.
5	147	Other deciduous	3+4	Non-saproxylic species associated with deciduous woods, but neither associated neither with non-intervention nor with open habitats.
6	16	Conifer saproxylic	2+4	Saproxylic species with preference for coniferous trees.
7	55	Conifer obligate	2	Non-saproxylic species associated only with conifers or coniferous woodland.
8	39	Conifer facultative	2+3	Non-saproxylic species preferring conifers or coniferous woodland, but also associated with deciduous trees or open habitats.
Total	626	Forest species		

Basic zones were changed for 15% of the 626 species after expert consultation (S2 Table shows final zone preferences). For 532 species (85%) the consulted species experts agreed with the basic zone(s) noted in table 3, while 71 species were given a supplementary zone, 5 species a changed zone and 18 species one zone less in order to match expert knowledge.

Species referred to zone 3 (Active zone) include many multi-habitat species where woodland may be a less important marginal habitat, while open habitats like grass- or heathlands are the primary biotope. For such species zone 4 Untouched, would be unnecessarily expensive or even counter-productive. Optimal biotopes for such species (e.g. light-loving insects like butterflies

(*Papilionoidea*)) are open habitats surrounded by or intermixed with woods (managed or unmanaged) providing a warm and calm microclimate, with transient scrub or tall herb communities. Other examples of zone 3 species include saproxylic beetles (*Coleoptera*) needing both rich nectar sources from flowers and warm forest rims with dead wood and veteran trees. Loss of open habitat to succession and tree encroachment is an important threat to these species (Lindhe et al. 2005; Nilsson 2009). In line with this the protection of zone 3 does not include a total cessation of wood harvest, but focusses on active management of woodland and of open habitats intermixed with trees or groves. The combination of open habitat management with some wood-harvest allows zone 3 to potentially have relatively low costs, but with a rather high level of uncertainty reflected in the analysis cost.

In order to run the Marxan optimization a number of assumptions need to be made about conservation target and other input. The general objective of halting the loss of biodiversity was quantified into a target of getting at least 3 sites / 5 sites for each species protected in State Forests with a protection regime matching the ecological requirements of the species (Nilsson 2009; Villard & Jonsson 2009). There is no guarantee that 3 or 5 sites will be enough for long-term species survival, but for many threatened species it amounts to 100% of extant known sites in State Forests and can be supplemented by sites for the same species outside of the State Forests (Cabeza & Moilanen 2001; Justus et al. 2008; Petersen et al. 2016a; Tear et al. 2005).

Other inputs that were varied in two or more levels were cost (as money or as area, with several levels of cost %), which species groups to base the optimization on, and finally if already fully protected forests should be a priori locked as such in the analysis. Table 4 gives an overview of the assumptions and input for all 26 scenarios run. Not all combinations of assumptions were run because of the large number of possible combinations (192). Instead scenarios were successively added in order to allow pairwise comparisons. Assumptions that resulted in relatively expensive, less effective or unrealistic solutions were dis-continued. In this way sensitivity to the various assumptions could be assessed.

Scenarios including only priority A species implicitly make the assumption that priority B species can persist in the matrix without extra protection (zone 1). This has by definition been the case until now because species were only taken as priority B if they were not in decline. On the other hand the species in decline have a diversity of ecological preferences, requirements and threats, meaning that diversity in protection regime is necessary. This is reflected in the differences between zones 2 (Conifer), 3 (Active) and 4 (Untouched).

Forests already protected as untouched were a priori locked to the corresponding zone 4 in scenario O – Z if the forest matched the following criteria: 1) 100% of the total forest area already decided protected untouched AND woodland area at least 5 hectares, OR 2) At least 100 hectares of woodland already protected as untouched AND it occupies more than 45% of the forest area. The cut-off levels of 5 ha and 45% were selected to ensure inclusion of large and important extant reserves without a priori locking a long list of forests to zone 4. Seven forests matched the criteria (S3 Table).

Table 4. Overview of the 26 scenarios.

Scenario	Target (Reps.)	Cost Zone 2 (%)	Cost Zone 3 (%)	Species (N)	Priority species included	Conifer associated species included?	Cost as money or area?	7 already untouched forests locked
A	Five	25	100	626	All	Yes	Money	No
B	Five	25	100	626	All	Yes	Area	No
C	Five	25	100	516	All	No	Money	No
D	Five	25	100	516	All	No	Area	No
E	Five	25	100	304	Priority A	Yes	Money	No
F	Five	25	100	304	Priority A	Yes	Area	No
G	Three	25	100	304	Priority A	Yes	Money	No
H	Three	25	100	304	Priority A	Yes	Area	No
I	Five	25	75	626	All	Yes	Money	No
J	Five	25	75	626	All	Yes	Area	No
K	Five	25	75	516	All	No	Money	No
L	Five	25	75	516	All	No	Area	No
M	Five	25	75	304	Priority A	Yes	Money	No
N	Five	25	75	304	Priority A	Yes	Area	No
O	Three	25	75	304	Priority A	Yes	Money	Yes to z4
P	Three	25	75	304	Priority A	Yes	Area	Yes to z4
Q	Five	25	75	304	Priority A	Yes	Money	Yes to z4
R	Five	25	75	304	Priority A	Yes	Area	Yes to z4
S	Five	10	75	626	All	Yes	Money	Yes to z4
T	Three	10	75	626	All	Yes	Money	Yes to z4
U	Five	10	75	304	Priority A	Yes	Money	Yes to z4
V	Three	10	75	304	Priority A	Yes	Money	Yes to z4
W	Five	10	50	626	All	Yes	Money	Yes to z4
X	Three	10	50	626	All	Yes	Money	Yes to z4
Y	Five	10	50	304	Priority A	Yes	Money	Yes to z4
Z	Three	10	50	304	Priority A	Yes	Money	Yes to z4

Cost was always set at 100% for zone 4 (Untouched) and at 0% for zone 1 (normal or available zone). Reps. = representations.

The first 18 scenarios (A-R) were pairwise identical except for costs being as money versus as woodland area (Table 4). To ensure that all polygons had a non-zero cost as required by Marxan, 1,000 kroner (approx. 133 Euros) was added to all costs before calibration and runs and subtracted from costs after runs.

In order to produce valid, robust results and to run scenarios efficiently, standard Marxan calibrations were undertaken for number of runs, number of iterations and Species Penalty Factors, SPF (Ardron et al. 2010; Segan et al. 2011; Watts et al. 2008a, 2008b, 2009, 2011). Because all targets were not simultaneously achievable the methods of calibration in Watts et al.

(2008a) were applied (Watts et al. 2011). As a standard 100 runs was chosen as in Watts et al. (2008a) although scenario results were already very similar for number of runs above 10. Calibration showed that scenario results were similar above 10,000 iterations. Because slight lowering of cost continued up to 10 million iterations that value was chosen. The difference between the calibrated SPF for money and area scenarios (7.188 and 7.75 respectively) had no effect on zone results so the average SPF figure of 7.47 was used. The calibrated input settings and Species Penalty Factor were kept constant over all scenarios.

Success rate for scenarios was assessed by 1) cost (annual net income foregone) and by 2) how many of the 304 priority A species that achieved their target. For species with occurrence in fewer polygons than the target level (3 or 5) the target was truncated to achieving 100% of forests with occurrence. As a supplement and to assess how far off-target species were, the relative target achievement for each of the 304 priority A species in each scenario was computed. The average target achievement (ATA) equals 1 if all species reached their target.

On the basis of results of the first 26 scenario runs, a final test of validity and sensitivity to assumptions was carried out as three variations of scenario Q (Q1, Q2 and Q3). These were run to see how much results would deviate if Q1) a more conservative subset of 115 study species overlapping Petersen et al. (2016b) was used targeting well-known and well-mapped species in Denmark, so that data could be assumed to be closer to presence-absence data (on species populations), and thereby better satisfy the theoretical assumptions behind optimization in Marxan; or Q2) zone preference was extended with zone 4 (Untouched) for all study species not having that preference defined, because given sufficient time, space and natural dynamics all species might be able to survive with non-intervention. Finally, in scenario Q3) zone preference was set to only zone 4 (Untouched) for all study species to evaluate how much the economic costs can be lowered by working with more than one protection zone. All other assumptions were unchanged from scenario Q. That scenario was chosen because it had intermediate cost assumptions and highest absolute target achievement.

Results

Study species occurred in 692 State Forest polygons (70.9%) of which 670 polygons with presence of defined forest species were included in the Marxan analyses (woodland total 103,234 ha). The remaining 306 polygons without known occurrence of threatened forest species generally had little woodland area (total 2,684 ha) and were manually assigned to zone 1 (Normal zone).

European hare (*Lepus europeaus*) was the most widely distributed threatened species being known from 321 different polygons, while 652 study species (396 forest species) each occurred in less than 5 polygons (Fig 1a). Overall, fungi and insects dominated the dataset, in line with the dominance of these species groups in the Danish biota (and red list) (Fig 1a). Fungi (incl. lichens) clearly dominated among species with records in less than 15 polygons, while insects had a more even distribution across frequency classes (Fig 1b). Birds, herptiles and to a lesser extent mammals tended to have much wider distributions than species in other taxonomic groups.

Hotspots, i.e. polygons with at least 100 threatened study species were widely spread over Denmark and comprised seven forest polygons in the size range 538 to 3845 ha. On average 25% of their wooded area was already protected, i.e. six of them had protection corresponding to zone 3 Active (1-87% of each polygon) while untouched protection covered 3-24% of each polygon. Tisvilde Hegn (1992 ha) was the most species-rich forest having 192 different threatened species.

Fig 2 shows the zone affinities and taxonomic groups of the 626 threatened forest species known from the State Forests.

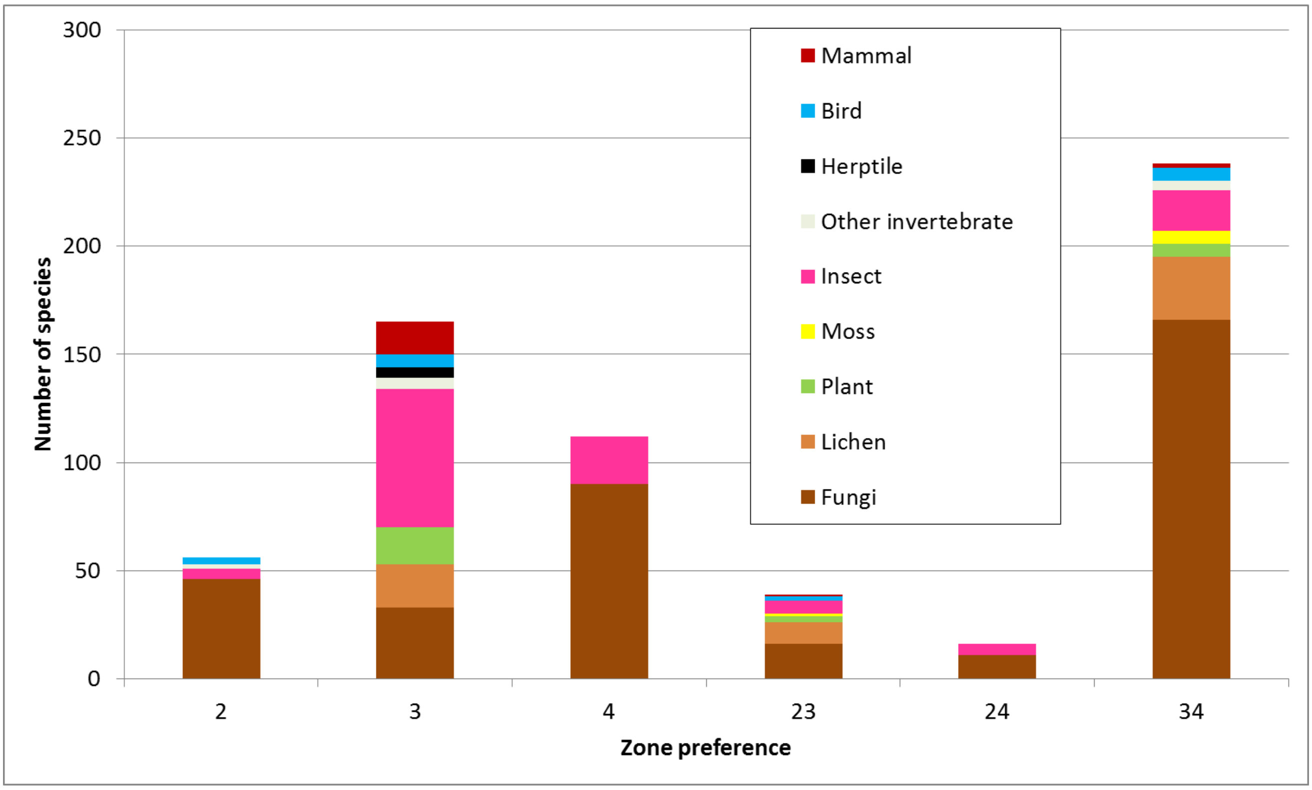

Fig 2. Zone affinity by taxonomic groups for the 626 threatened forest species.

The Marxan scenario runs assigned 450 forest polygons to a non-varying zone. This combined with the above-mentioned 306 polygons without forest species meant that totally 756 (77.5%) of all forests were systematically placed in the same zone in all scenarios regardless of assumptions (Table 5), while 220 forests had zone assignment dependent on choice of assumptions.

Table 5. Assignment of 976 State Forests to zones across 26 scenarios.

	Short name	Forests (N)	Wooded area (ha)	Money value (%)	Details
Always zone 4	Untouched	20	7,824	11	S4 Table
Always zone 3	Active	55	9,044	9	S5 Table
Always zone 2	Conifer	0	0	0	None
Zone variable	-	220	62,253	59	S6 Table
Always zone 1	Normal	681	26,797	21	S7 Table
Total		976	105,918	100	

Details about each forest can be seen in S4-S7 Tables (area, woodland types, existing protection, Marxan zones chosen, species numbers, percentage of observations in already protected parts of the forest, and zone results for scenarios O and Q if variable).

Depending on scenario 26-58% of the State Forest wooded area was assigned to zone 1 (Normal), while 9-23% was assigned to the untouched zone 4 (Table 6 and S8 table). 0-24% and 15-41% of the wooded area was assigned to Zone 2 (Conifer) and zone 3 (Active) respectively, showing the wide variability of results. Economic cost varied over scenarios from 26-69% loss of potential annual net income from wood harvest.

Table 6. Average scenario results grouped by assumptions and number of included species. Sorted by "Target" and then by "Target met".

Target	Target met (of 304 species)	Scenarios	N scenarios	N species included	Cost assumptions	z1 area %	z2 area %	z3 area %	z4 area %	cost% annual	z4 (ha)	z4 (n)
3	255	TX	2	626	Low end	36	24	24	16	36 to 43	17338	61
3	259	GHOPVZ	6	304	High and low	58	13	18	11	26 to 37	11565	40
5	199	CDKL	4	516	High end	39	0	39	21	58 to 69	22606	80
5	218	ABIJSW	6	626	High and low	26	24	29	20	43 to 61	21623	74
5	230	EFMNR	5	304	High end	38	20	27	16	46 to 54	16483	51
5	231	QUY	3	304	Medium-low	37	20	29	14	38 to 46	15281	50

z = zone. All area measures deal with woodland area, i.e. excluding unwooded areas like grasslands etc. Range is only given for cost%, because range was small or zero for other columns. See S8 table for detailed results for each scenario.

Area-based solutions were on average 0.16% more expensive than money-based solutions (range: 0.72% cheaper to 1.02% more expensive, S8 table). Target achievement measured as number of priority A species matching target was on average 0.07% better for area-based scenarios (range:

0.93% worse to 1.29% better). As these differences were minor and monetary cost was deemed most relevant, the last 8 scenarios were run with money-based cost only.

Exclusion of species associated mainly with conifers (Scenario C, D, K, L) was 8.3 to 12.0% more expensive than including them (Table 6, S8 table). The reason was that no forests were assigned to the less expensive zone 2 Conifer, so that all species protection even of species with broad preferences, e.g. forest-glade species, had to be in the more expensive zones 3 and 4. Target achievement was also low, so conifer preferring species were not excluded in the following scenarios.

Scenarios including both priority A and B species (scenario A, B, I, J, S, T, W, X) were 11-43% more expensive and with 1.2-7.3% lower target achievement than scenarios based only on priority A species (Table 6, S8 table).

Lowering cost assumptions from e.g. 100 to 75% (zone 3) or from 25 to 10% (zone 2) of course resulted in less costly results but made no changes (scenarios A/I, B/J, E/M, F/N, Q/U, S/W, T/X, U/Y, V/Z) or only minor changes (O/V) to target achievement, implying that the biological input data were the main driver of zone results. The zone-forest constellation was thus identical for scenarios Q, U and Y although cost assumptions were different (Table 6). Similarly, zone constellation was almost identical for scenarios O, V and Z (S8 table). This simple sensitivity analysis showed that zone results were generally not sensitive to changes in the economic cost assumptions.

A priori locking seven already untouched forests to zone 4 (scenario Q compared to M) resulted in 0.78% improvement of average target achievement to the highest level of any 5-representation money-based scenario but at a 1.1% higher cost (S8 table). As target achievement had high priority, and it was not on the agenda to delete protection of already protected forests, all further scenarios kept the a priori lock to zone 4 for these seven forests.

Not surprisingly, a change of target from 5 to 3 representations of each species had a major influence on results as seen from e.g. scenario G compared to E, or O compared to Q (S8 table). In both cases about 30 more (12-13%) priority A species achieved the target at a greatly reduced (-29.5 to -30.4%) expense. But then it must be noted that the absolute protection level is not as high as in the 5 representation scenarios (Fig 3). Scenario Q/U/Y with 5 as representation target had almost as many species (258/258/258) represented 3 times as the corresponding 3 representation scenarios O/V/Z (261/258/258) and had many more species covered 5 times.

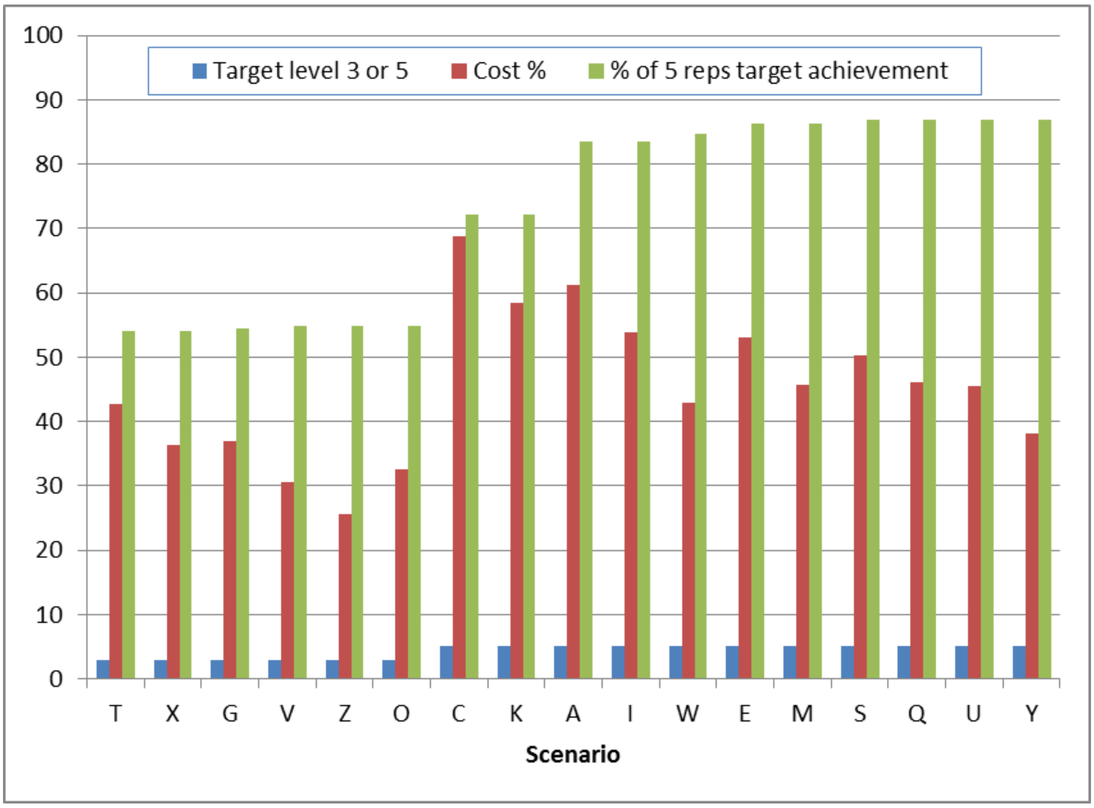

Fig 3. Money-based scenarios sorted by target level, by relative achievement of 5 representation target, and finally by cost (% loss of annual income from wood harvest). The most cost-efficient scenarios are thus to the right.

The highest absolute target achievement occurred for five representations identically in scenarios Q, U and Y, where costs varied from 38-46% of net income depending on the cost assumptions (Table 6). The zone constellation of these three scenarios was identical and un-influenced by the varying cost assumptions making this constellation of protection robust and most cost-efficient of the five representation scenarios.

The zone constellation of scenario Q, U and Y included 50 forests selected for untouched (zone 4) covering 15,281 hectares of woodland, including 2,256 ha already protected as untouched, besides 2,676 ha protected as grazing forest or selective cutting for biodiversity reasons. The hitherto unprotected parts thus comprise 10,349 ha. The gap species, i.e. species not meeting their target are identical for scenario Q, U and Y and listed in S9 table with details.

Table 7. Variant scenario results compared to scenario Q.

Target met (of 304 species)	Scenario	N species included	Cost assumptions	z1 area %	z2 area %	z3 area %	z4 area %	cost% annual	z4 (ha)	z4 (n)
231	Q	304	intermediate	37	20	29	14	46	15281	50
166	Q1	115	intermediate	57	16	15	12	33	12771	33
NA	Q2	304	intermediate	47	9	19	25	48	26119	69
NA	Q3	304	intermediate	47	0	0	54	59	56679	203

NA = Not applicable. z = zone. Not noted assumptions are as in scenario Q (see table 4).

The variant scenario Q1 based on a more limited number of well-known and well-mapped species assigned 33 forests to zone 4 Untouched (12,771 ha) as opposed to 50 forests and 15,281 ha in scenario Q (Table 7). It had costs of 33.1% instead of 46.1%, but missed the target for 138 of the 304 priority A species. For most taxon groups the relative proportion of gap-species was similar between scenario Q and Q1 (results not shown), but lichens were missed to a greater extent (20% of gap-species being lichens in Q1 opposed to 8% in Q) and insects to a lesser extent (30% of gap-species being insects in Q1 opposed to 40% in Q).

The variant scenario Q2 where all species had preferences supplemented with zone 4 Untouched, assigned 69 forests to zone 4 Untouched (26,119 ha) opposed to the 50 forests and 15,281 ha in scenario Q (Table 7). It had costs of 48.1% instead of the 46.1% for scenario Q - the relatively small difference being due to smaller areas assigned to zones 2 (9,4%) and 3 (19,4%) compared to scenario Q.

The variant scenario Q3 with protection only possible in zone 4 (simulating no zoning) assigned 203 forests to protection at a cost of 58.9% of annual net income from wood harvest, compared to 46.1% for scenario Q (Table 7). The benefit of zoning thus corresponds to 21.7% in terms of money potentially saved compared to applying only non-intervention protection. If the lower cost assumptions in scenario U or Y for zone 2 and 3 protection are possible in reality, savings will be proportionally higher.

Discussion

In this study we show that, if carefully planned, the government decision of designating 13,300 ha of new protected forests (10,000 ha untouched and 3,300 ha other protection types) in the Danish State Forests should be able to provide most threatened species with relevant protection in all known sites for rare species (less than five occurrences in state forests), and in at least 5 sites for less rare species (Scenario Q, U and Y). Depending on cost assumptions, this implies a 38-46% loss of annual net income from wood harvest in the State Forests.

Combining results into an evaluation of the most cost-efficient constellation of forests to zones is not straightforward but was done separately for 3 and 5 representation targets and focusing on money-based scenarios with forests already protected as untouched locked as such. For five representations the highest target achievement was thus in scenario Q, U and Y with identical zone constellation, thereby being robust to the uncertainty of cost assumptions. Scenario Y had the lowest costs thereby being most cost-efficient. Since scenario Q had intermediate cost assumptions and matched well with the government decision for 10,000 ha of new untouched forest, it was taken as the most relevant scenario to use for further work and evaluation.

For three representations the highest money-based target achievement was in scenario O which at the same time had the fourth lowest costs of 26 scenarios thereby being cost-efficient. Scenarios V and Z had almost the same zone constellation and high target achievement with lower costs, thereby also being efficient if the lower cost assumptions are possible in reality. These scenarios had lower protection level than the government decision and were therefore less relevant in relation to the process of designating new untouched forest reserves.

How much protection is needed for long-term persistence of species is a difficult question (Tear et al. 2005). In the absence of population viability analyses the choice in this study was to compare two levels of representation (3 or 5 representations of each species) to be able to evaluate differences. Scenarios with 3 and 5 representation targets differed only slightly in the number of species with 3 representations, but the latter had many more species covered 5 times, improving chances of persistence. The target level of 5 representations can thus be superior in achieving the UN and EU biodiversity objective of halting the decline in biodiversity, but has c.30% higher costs.

Even for declining threatened species there will often be populations which live in the "unprotected" matrix in State Forests or on private land. These populations may complement the populations in protected areas thus enhancing persistence of the species (Brunet et al. 2010; Lindenmayer & Franklin 2002; Wilson et al. 2010) as long as they are not just population sinks (Pulliam 1988). Chances of persistence can thus be improved by enhancing habitat quality in the managed matrix or by targeting conservation effort on private lands. All Danish State Forests are subject to a policy to raise amounts of coarse deadwood and veteran trees (including retention trees) and enhance natural hydrology (Rigsrevisionen 2016) and are also certified by both the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). This is a substantial improvement to previous management regimes, and will undoubtedly improve habitat quality in the matrix, most likely enhancing survival and dispersal of threatened species between protected areas.

The refinement of "protection" to different categories or "zones" targeting species groups with different habitat requirements, and with differing economic costs was a primary reason for the choice of Marxan With Zones. Zoning was shown to be potentially more than 20% cheaper than simple full protection. But the attribution of zone preferences to species is demanding on input data regarding species ecological requirements, which are not always well understood or even erroneous in the data sources used.

As an example the habitat quality for species of zone 4 Untouched can be strongly influenced by grazing regime. With grazing at moderate (supposedly natural) levels in otherwise untouched woodland, many species of zone 3 Active will also often find their requirements satisfied. Missing, too high or too low grazing pressure can on the other hand be detrimental to the survival of many threatened species.

Similarly the definitions of zone 2 Conifer and zone 3 Active encompass a range of different protection and management types and intensities which are not directly linkable to the information on biotopes, threats and preferences for each species. Expert consultation showed a number of uncertainties and knowledge gaps regarding species preferences and need for protection regime, and results should thus be interpreted with care.

Scenarios excluding conifer-associated species were more expensive than scenarios including them because some forests were assigned to zone 3 or 4 instead of the less costly zone 2. The lower cost assumption for zone 2 was chosen because many of the threatened zone 2 species, e.g. the globally threatened ant *Formicoxenus nitidulus,* can have their requirements satisfied with continuation of more or less normal economic-based conifer forestry with only minor adjustments. The main reason for assessing the effect of excluding species of zone 2 (Conifer), was that Danish conifer woods are sometimes seen as low priority for conservation (Feilberg 2004; Petersen et al. 2016b), even though other studies have shown them to be of larger conservation importance than anticipated (Flensted et al. 2016).

The mentioned globally threatened ant – being small and unobtrusive – is only known and recognized by a few specialist entomologists. False absence (omission error) is an issue for this and many other species. False presence and other commission errors have been minimized as far as possible by careful quality checks of all data both by data suppliers and in this project. To minimize the effect of omission errors the study period was chosen 25 years long in order to include systematic national surveys of butterflies and flora started around 1991 and all later systematic "atlas-type" surveys. If nobody has recorded a threatened species from a site for 25 years, chances are good that the site is not important for that species.

Insufficient understanding of species-preferences might also lead to suboptimal results. Such error was minimized by using the best available systematic database- and literature-sources and finally adjusting by expert consultation. But even so there seems to be examples of species with broader or other preferences than the ones used as input, e.g. the fungi *Coprinus pannucioides* and *Leucocoprinus brebissonii,* assigned to untouched zone 4, were recorded in a young afforestation but not in any already untouched woodlands.

Because the real cost level of zone 2 and 3 is uncertain and variable, it was fortunate that results were not influenced to any great extent by change of cost assumptions. Zone-constellations remained constant over a wide range of costs. More detailed zone 2 and 3 planning will be necessary forest by forest for optimal protection and for more precise assessment of costs.

It was surprising that locking seven forests already fully protected to zone 4 did not result in a lowered target achievement (scenario Q compared to M) because these forests had been protected in the 1990'ies or earlier with no use of systematic conservation planning. On the contrary, scenario Q turned out to have 0.8% higher average target achievement and full achievement for 231 species instead of 229. This came at a 1.1% higher cost showing that the Marxan algorithms do not simply maximize target achievement but find a balance between target achievement and cost minimization.

It must be noted that due to the lack of solid presence-absence data the analyses were based on presence data only. Much of the presence data was based on citizen science data which is biased (Geldmann et al. 2016). This makes the resulting zone-constellations sub-optimal compared to a theoretically ideal situation.

The variant scenario Q1 used to assess sensitivity to some of the abovementioned biases showed 1) that the amount of species included has an important impact; 2) many threatened species can be missed if designations are based on only well-known and well-mapped threatened species, and 3) it makes a difference which taxon groups are included. This can be seen as a sign of complementarity in habitat requirements between e.g. the threatened lichens and insects, but also between well-known and less well-known species.

The variant scenarios Q2 and Q3 showed that zoning is efficient in lowering costs of protection. Zoning should at the same time enhance efficiency of species persistence assuming their requirements are sufficiently well-known and can be coupled with a relevant protection regime. The zoning approach of Marxan With Zones is thus superior to conservation planning discerning only between protected and non-protected areas as demonstrated by Watts et al. (2009).

Even the scenarios with highest target achievement missed out on dozens of priority A species. These gap species occurred in forests selected for a non-compatible zone due to optimization for co-occurring species with other ecological requirements. To reach a higher overall target achievement it will be necessary to apply a varied protection scheme with more than one zone in some of the forests having species with differing habitat requirements, e.g. forests with species needing semi-open habitats in one part and species needing closed forest conditions with deadwood in another part. Combination of zone 4 Untouched with a grazing regime mimicking primeval conditions should also be suitable for many species of zone 3 (and zone 2 if conifers are present) and theoretically be optimal even though not always possible to implement in reality.

After the Marxan analyses further work on the planned woodland reserves thus looked into optimization by diversifying protection regime in some forests. Detailed forest-by-forest GIS analysis of which parts of the forests harbor which species showed how much could be won by zoning internally. The Marxan results were very helpful in this process, by identifying the 48 (5%) forests with gap-species assigned to a non-compatible zone and thereby relevant for a more detailed look.

Area-based data on forest- and habitat-structures assessed as important for threatened species comprised another independent input to the State Forest designation process of new reserves. The Marxan results from the present study were combined with such other data, legal restrictions and other ecosystem services than biodiversity, e.g. recreational interests, as input to the government decision January 2018 (Naturstyrelsen 2018) identifying the new forest reserves and announcing them for public hearing. In the process between systematic conservation planning and final selection the sites usually shift somewhat (Schröter et al. 2014) which was also the case here but to a minor extent.

Conclusion

Marxan with Zones was used to develop examples of cost-efficient site networks which could represent known threatened forest species at least 3 or 5 times with a protection scheme matching their ecological requirements. Marxan with Zones proved to be effective in optimizing the site selection and target achievement for sites in the State Forests. The 976 sites and 1,066 threatened species were too many to make it realistic to optimize site selection in other ways.

The cost of example networks amounted to 26-69% of State Forest net income from forestry if whole forests were designated, depending on cost assumptions and representation target. The costs could be reduced and target achievement enhanced if large forests were only partially designated (covering mainly the relevant habitats of the occurring focal species) and the rest continued with normal operations.

The government decision of 10,000 hectares of new minimum-intervention reserves matched well with the Marxan outputs for some scenarios with target set at 5 representations (scenario Q, U and Y) because 4,932 of the 15,271 hectares these scenarios assigned to untouched was already protected in the 1990'ies. On the other hand the analyses highlight the need of many forest species for other types of protection besides minimum-intervention reserves. The Marxan examples include larger actively protected areas than currently decided. More active protection thus seems necessary for efficient protection of such species besides the decided expansion of minimum-intervention.

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Appendix A. Supplementary material

S1 Table. Data sources and records.

S2 Table. Species data. Details of status, preferences and zones for the 626 forest species.

S3 Table. A priori fully protected forests. The seven forests locked to zone 4 in scenario O-Z.

S4 Table. Zone 4 forests. Details of 20 forests which all scenarios put in zone 4 (Untouched protection).

S5 Table. Zone 3 forests. Details of 55 forests which all scenarios put in zone 3 (Active protection).

S6 Table. Variable forests. Details of 220 forests variably selected to different zones by scenarios.

S7 Table. Zone 1 forests. Details of 681 forests which were always assigned to zone 1 (Normal).

S8 Table. Results of scenarios. Details of 26 scenarios and 3 variants with varying assumptions.

S9 Table. Gap species of scenario Q. Details of 73 species not reaching target protection in scenario Q.

References

Alexander, K.N.A. (2002). The invertebrates of living and decaying timber in Britain and Ireland - a provisional annotated checklist. English Nature Research Report No. 467, Peterborough, UK, 142 pp.

Andersson, L., & Appelqvist, T. (1990). The influence of Pleistocene megafauna on nemoral and boreonemoral ecosystems: an hypothesis with implications for nature conservation. Svensk Botanisk Tidskrift, 84(6), 355-368.

Anonymous (1994). Strategy for natural forests and other forest types of high conservation value in Denmark. The Ministry of Environment, The National Forest and Nature Agency. 48 pp.

Anonymous (2016). Nature Package Agreement (in Danish), Ministry of Environment and Food of Denmark. http://mfvm.dk/fileadmin/user_upload/Natturpakke-2016.pdf

Ardron, J.A., Possingham, H.P., & Klein, C.J. (eds). 2010. Marxan Good Practices Handbook, Version 2. Pacific Marine Analysis and Research Association, Victoria, BC, Canada. 165 pages. www.pacmara.org.

Bernes, C., Jonsson, B. G., Junninen, K., Lõhmus, A., Macdonald, E., Müller, J., & Sandström, J. (2015). What is the impact of active management on biodiversity in boreal and temperate forests set aside for conservation or restoration? A systematic map. Environmental Evidence, 4(1), 25.

Beyer, H. L., Dujardin, Y., Watts, M. E., & Possingham, H. P. (2016). Solving conservation planning problems with integer linear programming. Ecological Modelling, 328, 14-22.

Boch, S., Prati, D., Hessenmöller, D., Schulze, E. D., & Fischer, M. (2013). Richness of lichen species, especially of threatened ones, is promoted by management methods furthering stand continuity. PloS one, 8(1), e55461.

Brunet, J., Fritz, Ö., & Richnau, G. (2010). Biodiversity in European beech forests–a review with recommendations for sustainable forest management. Ecological Bulletins, 53(7).

Buchwald, E., (2005). A hierarchical terminology for more or less natural forests in relation to sustainable management and biodiversity conservation, Proceedings: Third expert meeting on harmonizing forest-related definitions for use by various stakeholders. Food and Agriculture Organization of the United Nations, Rome, 17-19 January 2005.

Buchwald, E. (2018a). Threatened species occurrences, Denmark 1991-2015. GBIF-dataset at https://doi.org/10.15468/5cpovj

Buchwald, E. (2018b). Analysis and prioritization of future efforts for Danish biodiversity – with particular regard to Nature Agency lands. Phd-Thesis. Natural History Museum of Denmark, University of Copenhagen.

Burrascano, S., Keeton, W. S., Sabatini, F. M. & Blasi, C. (2013). Commonality and variability in the structural attributes of moist temperate old-growth forests: a global review. Forest Ecology and Management, 291, 458-479.

Cabeza, M., & Moilanen, A. (2001). Design of reserve networks and the persistence of biodiversity. Trends in ecology & evolution, 16(5), 242-248.

CBD (2010): COP 10 Decision X/2. Strategic Plan for Biodiversity 2011-2020. https://www.cbd.int/decision/cop/?id=12268

Christensen, M. & Emborg, J. (1996). Biodiversity in natural versus managed forest in Denmark. Forest Ecology and Management, 85(1-3), 47-51.

DANBIF, 2016. Species checklist Denmark, DanBIF - Danish Biodiversity Information Facility, University of Copenhagen, www.allearter.dk (accessed February 1st 2016)

Dirzo, R., Young, H. S., Galetti, M., Ceballos, G., Isaac, N. J., & Collen, B. (2014). Defaunation in the Anthropocene. science, 345(6195), 401-406.

EIONET 2013a: Reporting under Article 12 of the Birds Directive (period 2008-2012). Member State Deliveries. Denmark. http://bd.eionet.europa.eu/activities/Reporting/Article_12/Reports_2013/Member_State_Deliveries

EIONET 2013b: Reporting under Article 17 of the Habitats Directive (period 2007-2012). Member States Deliveries. Denmark. http://bd.eionet.europa.eu/activities/Reporting/Article_17/Reports_2013/Member_State_Deliveries

EU (1979). Council Directive of 2 April 1979 on the conservation of wild birds (79/409/EEC). Official J. Eur. Communities, (L103).

EU (1992). Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Union, 206, 7-50.

Feilberg, J. (Ed.) (2004). Proceedings of conference March 6th 2004 on the coniferous forests of Denmark (in Danish with an English summary: Quaternary history of conifers in Denmark). Flora og fauna 110 (3):1-138, http://jydsknaturhistorisk.dk/Florafauna/FloraogFauna2004-3.pdf

Flensted, K. K., Bruun, H. H., Ejrnæs, R., Eskildsen, A., Thomsen, P. F., & Heilmann-Clausen, J. (2016). Red-listed species and forest continuity–A multi-taxon approach to conservation in temperate forests. Forest Ecology and Management, 378, 144-159.

Geldmann, J., Joppa, L. N., & Burgess, N. D. (2014). Mapping change in human pressure globally on land and within protected areas. Conservation biology, 28(6), 1604-1616.

Geldmann, J., Heilmann-Clausen, J., Holm, T.E., Levinsky, I., Markussen, B., Olsen, K., Rahbek, C. & Tøttrup, A.P., 2016. What determines spatial bias in citizen science? Exploring four recording schemes with different proficiency requirements. Diversity and Distributions 22:1139–1149. DOI: 10.1111/ddi.12477.

Götmark, F. (2013). Habitat management alternatives for conservation forests in the temperate zone: Review, synthesis, and implications. Forest Ecology and Management, 306, 292-307.

IUCN, 2015. The IUCN Red List of Threatened Species. Denmark search May 2015, permalink: http://www.iucnredlist.org/search/link/554c4d07-c8f7a9d9 .

Joppa, L. N., O'Connor, B., Visconti, P., Smith, C., Geldmann, J., Hoffmann, M., ... & Ahmed, S. E. (2016). Filling in biodiversity threat gaps. Science, 352(6284), 416-418.

Justus, J., Fuller, T., & Sarkar, S. (2008). Influence of Representation Targets on the Total Area of Conservation-Area Networks. Conservation Biology, 22(3), 673-682.

Kahle, H. P. (Ed.). (2008). Causes and consequences of forest growth trends in Europe: Results of the recognition project (Vol. 21). Brill.

Knight, A. T., Cowling, R. M., Rouget, M., Balmford, A., Lombard, A. T., & Campbell, B. M. (2008). Knowing but not doing: selecting priority conservation areas and the research–implementation gap. Conservation biology, 22(3), 610-617.

Kukkala, A. S., & Moilanen, A. (2013). Core concepts of spatial prioritisation in systematic conservation planning. Biological Reviews, 88(2), 443-464.

Köhler, F. (2000): Saproxylic beetles in nature forests of the northern Rhineland. Comparative studies on the saproxylic beetles of Germany and contributions to German nature forest research (in german). - Schrr. LÖBF/LAfAO NRW (Recklinghausen) 18, 1-351. Database downloaded 17/3 2015 from http://www.koehleroptera.de/publikationen/buecher/totholz2000.html .

Lindenmayer, D. B., & Franklin, J. F. (2002). Conserving forest biodiversity: a comprehensive multiscaled approach. Island Press.

Lindhe, A., Lindelöw, Å., & Åsenblad, N. (2005). Saproxylic beetles in standing dead wood density in relation to substrate sun-exposure and diameter. Biodiversity and Conservation, 14(12), 3033-3053.

Lundström, J., Öhman, K., Rönnqvist, M., & Gustafsson, L. (2016). Considering future potential regarding structural diversity in selection of forest reserves. PloS one, 11(2), e0148960.

Margules, C. R., & Pressey, R. L. (2000). Systematic conservation planning. Nature, 405(6783), 243.

Moilanen, A., Wilson, K. A., & Possingham, H. (2009). Spatial conservation prioritization: quantitative methods and computational tools (pp. 1-304). Oxford University Press.

Naturstyrelsen (2018). Designation of forest for biodiversity (in Danish: Udpegning af skov til biodiversitetsformål). 38 pp. http://naturstyrelsen.dk/media/230273/udpegning-af-skov-til-biodiversitetsformaal.pdf (accessed 22nd January 2018).

Newbold, T., Hudson, L. N., Hill, S. L., Contu, S., Lysenko, I., Senior, R. A., ... & Day, J. (2015). Global effects of land use on local terrestrial biodiversity. Nature, 520(7545), 45-50.

Nielsen, A.B. 2009 Openness and composition of the primeval Atlantic forest landscape and the impact of grazing studied paleobotanically (in Danish with English summary and figure captions). 79pp. http://www.geus.dk/program-areas/nature-environment/denmark/rapporter/geus_rap_2009_23.pdf

Nieto, A. & Alexander, K.N.A. (2010). European red list of saproxylic beetles. Luxembourg. Publications Office of the European Union. 45 pp.

Nilsson, S.G. (2009) Selecting biodiversity indicators to set conservation targets: species, structures or processes? Page 79-108 in: Villard, M. A., & Jonsson, B. G. (Eds.). (2009). Setting conservation targets for managed forest landscapes. Conservation Biology No. 16. Cambridge: Cambridge University Press. 411 pp.

Nord-Larsen, T., Johannsen, V. K., Riis-Nielsen, T., Thomsen, I. M., Suadicani, K., Vesterdal, L., ... Jørgensen, B. B. (2016). Skove og plantager 2015: Forest statistics 2015. Institut for Geovidenskab og Naturforvaltning, University of Copenhagen. 129 pp.

Odgaard, B. V. (1994). The Holocene vegetation history of northern west Jutland, Denmark. Nordic Journal of Botany, 14(4), 402-402.

Owen-Smith, R. N. (1992). Megaherbivores: the influence of very large body size on ecology. Cambridge university press.

Petersen, A.H., Strange, N., Anthon, S., Bjørner, T.B. & C. Rahbek, 2016a. Conserving what, where and why? Cost-efficient measures to conserve biodiversity in Denmark. Journ. f. Nature Conservation 29:33-44.

Petersen, A. H., Lundhede, T., Bruun, H. H., Heilmann-Clausen, J., Thorsen, B. J., Strange, N., & Rahbek, C. (2016b). Bevarelse af biodiversiteten i de danske skove: en analyse af den nødvendige indsats, og hvad den betyder for skovens andre samfundsgoder. Center for Macroecology, evolution and Climate. University of Copenhagen. 113 pp.

Pimm, S. L., Jenkins, C. N., Abell, R., Brooks, T. M., Gittleman, J. L., Joppa, L. N., ... & Sexton, J. O. (2014). The biodiversity of species and their rates of extinction, distribution, and protection. Science, 344(6187), 1246752.

Possingham, H., Wilson, K. A., Andelman, S. J., & Vynne, C. H. (2006). Protected areas: goals, limitations, and design. In: Groom, M. J., Meffe, G. K., & Carroll, C. R., Principles of conservation biology. Sunderland: Sinauer Associates., third ed. pp. 509-533.

Pulliam, H. R. (1988). Sources, sinks, and population regulation. The American Naturalist, 132(5), 652-661.

Rigsrevisionen (2016) Evaluation of biodiversity management in the State Forests of Denmark (in Danish: Beretning om Miljø- og Fødevareministeriets forvaltning af biodiversitet i statsskovene). 46 pp. http://www.rigsrevisionen.dk/media/2104276/sr1815.pdf

Schröter, M., Rusch, G. M., Barton, D. N., Blumentrath, S., & Nordén, B. (2014). Ecosystem services and opportunity costs shift spatial priorities for conserving forest biodiversity. PloS one, 9(11), e112557.

Segan, D. B., Game, E. T., Watts, M. E., Stewart, R. R., & Possingham, H. P. (2011). An interoperable decision support tool for conservation planning. Environmental Modelling & Software, 26(12), 1434-1441.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Folke, C. (2015). Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223), 1259855.

Stokland, J. N., & Meyke, E. (2008). The saproxylic database: an emerging overview of the biological diversity in dead wood. In Revue d'écologie, 2008, SUP10" 4ème Colloque sur la Conservation des Coléoptères Saproxyliques", Vivoin, Sarthe, FRA, 2006-06-27. Société nationale de protection de la nature et d'acclimatation de France, Paris (FRA). Database (still in development) downloaded 18/3 2015 from http://radon.uio.no/wdd/Default.aspx?ShortcutNewObject=true .

Tear, T. H., Kareiva, P., Angermeier, P. L., Comer, P., Czech, B., Kautz, R., ... & Scott, J. M. (2005). How much is enough? The recurrent problem of setting measurable objectives in conservation. AIBS Bulletin, 55(10), 835-849.

Timmermann, A., Damgaard, C., Strandberg, M. T., & Svenning, J. C. (2015). Pervasive early 21st-century vegetation changes across Danish semi-natural ecosystems: more losers than winners and a shift towards competitive, tall-growing species. Journal of applied ecology, 52(1), 21-30.

Tybirk, K., & Strandberg, B. (1999). Oak forest development as a result of historical land-use patterns and present nitrogen deposition. Forest ecology and management, 114(1), 97-106.

Vandekerkhove, K., De Keersmaeker, L., Walleyn, R., Köhler, F., Crevecoeur, L., Govaere, L., ... & Verheyen, K. (2012). Reappearance of old growth elements in lowland woodlands in northern Belgium: do the associated species follow?. Silva Fennica, 45(5), 909-935.

Venter, O., Fuller, R. A., Segan, D. B., Carwardine, J., Brooks, T., Butchart, S. H., ... & Possingham, H. P. (2014). Targeting global protected area expansion for imperiled biodiversity. PLoS Biology, 12(6), e1001891.

Venter, O., Magrach, A., Outram, N., Klein, C. J., Marco, M. D., & Watson, J. E. (2017). Bias in protected-area location and its effects on long-term aspirations of biodiversity conventions. Conservation Biology.

Vera, F. W. M. (2000). Grazing ecology and forest history. CABI publishing.

Villard, M. A., & Jonsson, B. G. (Eds.). (2009). Setting conservation targets for managed forest landscapes. Conservation Biology No. 16. Cambridge: Cambridge University Press. 411 pp.

Virkkala, R., Heikkinen, R. K., Fronzek, S., & Leikola, N. (2013). Climate change, northern birds of conservation concern and matching the hotspots of habitat suitability with the reserve network. PLoS One, 8(5), e63376.

Watson, J. E., Darling, E. S., Venter, O., Maron, M., Walston, J., Possingham, H. P., ... & Brooks, T. M. (2016). Bolder science needed now for protected areas. Conservation Biology, 30(2), 243-248.

Watts, M. E., Steinback, C. & C. Klein, 2008a. User Guide: Applying Marxan with Zones. North central coast of California marine study. University Of Queensland.

Watts, M. E., C. K. Klein, R. Stewart, I. R. Ball & H. P. Possingham. 2008b. Marxan with Zones (V1.0.1): Conservation Zoning using Spatially Explicit Annealing, a Manual. University Of Queensland.

Watts, M. E., I. R. Ball, R. S. Stewart, C. J. Klein, K. Wilson, C. Steinback, R. Lourival, L. Kircher & H. P. Possingham, (2009) Marxan with Zones – software for optimal conservation-based land- and sea-use zoning. Environmental Modelling & Software 24:1513-1521.

Watts, M., Stewart, R., Segan, D. & Kircher, L., 2011. Using the Zonae Cogito Decision Support System. Manual prepared by Applied Environmental Decision Analysis Centre. Ecology Centre, Univ. Queensland.

Wilson, K. A., Meijaard, E., Drummond, S., Grantham, H. S., Boitani, L., Catullo, G., ... & Watts, M. (2010). Conserving biodiversity in production landscapes. Ecological Applications, 20(6), 1721-1732.

Wind, P. & Pihl, S. (eds.), 2010. The Danish Red List. The National Environmental Research Institute, Aarhus University. redlist.dmu.dk (updated April 2010).

S1 Table

S1 Table. Data sources and records. Used records include only study species and the years 1991-2015.

	Records			
Data provider	**Total**	**Used**	**Date accessed**	**Reference**
Atlas- & observation-database (Birdlife Denmark, DOFbasen)	17.961.625	110.029	17/12 2015	http://dofbasen.dk/
Birds & Nature web-database (license B05/2014, Fugle & Natur)	1.958.677	57.401	2/12 2015	http://www.fugleognatur.dk/
Bugbase (Lepidopterological Society, Denmark)	859.969	23.689	21/12 2015	http://www.bugbase.dk/
Biodiversity map, HNV-forest update (Danish Nature Agency)	54.997	22.656	2/5 2016	Johannsen, V. K., 2015 & digital data 2/5 2016
Biodiversity map, 2014 (Danish Nature Agency)	23.185	20.919	9/12 2015	Ejrnæs et al., 2014 & digital update accessed 9/12 2015
Danish fungal records database (Danish Mycological Society)	559.159	20.358	17/11 2015	http://www.svampeatlas.dk/
An Annotated Atlas of the Danish Butterflies (Zoological Museum)	199.307	5.288	15/1 2014	Stoltze, M., 1994
"Forests of special nature value § 25" (Danish Nature Agency)	49.894	2.399	1/12 2015	Naturstyrelsen 2007
Danish Nature Agency database on things to protect, "Pas-paa-kort"	8.526	1.865	3/11 2015	Naturstyrelsen 2015
Atlas Flora Danica data 1992-2013, redlist & forest extract (Danish Botanical Society)	123.334	1.459	22/4 2014	Hartvig, P., 2015
Entomological Society of Fünen database (Fynske insekter)	167.905	971	20/1 2016	http://www.fynskeinsekter.dk/
Spiders of Denmark online database	31.731	158	3/11 2015	http://www.danmarks-edderkopper.dk/
Epiphytic lichens and bryophytes in the forests of Lille Vildmose in 2013	210	81	19/4 2016	Fritz, Ô., 2014
Roof-top insect study 1992-2009 (Zoological Museum)	44.088	57	14/1 2016	Thomsen et al., 2015
Digital databases of invertebrates (Natural History Museum of Denmark)	69.436	35	1/12 2015	Stein, M., 2015
Epiphytic lichens in the forest of Kås in 2002	85	29	19/4 2016	Larsen, R.S., 2002
Epiphytic lichens and bryophytes on oak in the forest of Tofte 2012-2013	104	28	19/4 2016	Mouridsen, M.T., 2014
Status books on the forests of Tofte & Høstemark	3.331	11	19/4 2016	Hald-Mortensen, P., 2012 & 2002
Danish Topographical Botanical Survey online, "TBU collections"	3.299	5	21/12 2015	http://www.daim.snm.ku.dk/TBU-en
Hepatics at the Herbarium C. (Natural History Museum of Denmark)	9.306	0	3/11 2015	http://www.daim.snm.ku.dk/hepatics
Total	22.128.168	267.438	Total	

S1 Table References:

Ejrnæs et al., 2014. *Biodiversitetskort for Danmark*. Rapp 112/2014, DCE.

Fritz, Ô. 2014. *Epiphytic lichens and bryophytes in the forests of Lille Vildmose in 2013*. Naturcentrum report 2014-03-04, 34 pp.

GBIF 2016. GBIF.org (5th September 2016) *GBIF Occurrence Download* http://doi.org/10.15468/dl.obr3f0

Hald-Mortensen, P. 2002. *Høstemark - status 2001*. AVJF, 302 pp.

Hald-Mortensen, P. 2012. *Tofte Skov og Mose - status 2012*. AVJF, 387 pp.

Hartvig, P., 2015. *Atlas Flora Danica*. 3 volumes. Gyldendal, København.

Johannsen, V. K., 2015. *Udvikling af et High Nature Value - HNV-skovkort for Danmark*. IGN rapport, nov 2015.

Larsen, R.S., 2002. *Biodiversitet, kvistflora og kvælstofbelastning. Kås Skov, 2002*. KU speciale rapport.

Mouridsen, M.T., 2014. *Epifytiske laver og mosser på eg i Tofte Skov. Status 2012-13*. Specialerapport, KU Biol. Inst. 2014.

Naturstyrelsen, 2007. *Data from 2007 COWI project "Forests of special nature value § 25"*. Unpublished.

Naturstyrelsen, 2015. *Database on things to protect, "Pas-paa-kort", Naturreg*. Unpublished.

Naturstyrelsen, 2016. *Digital biodiversity map 2016*, updatet ArcGis files March 18th 2016. Unpublished.

Stein. M., in litt. 2015. *RE: Forespørgsel på invertebratdata til mit PhD*. Email 1/12 2015 from SNHM.

Stoltze, M., 1994. *An Annotated Atlas of the Danish Butterflies*. Zoological Museum, 134 pp.

Thomsen, P. F., Jørgensen, P. S., Bruun, H. H., Pedersen, J., Riis-Nielsen, T., Jonko, K., Słowińska, I., Rahbek, C., Karsholt, O., 2015. *Resource specialists lead local insect community turnover associated with temperature – analysis of an 18-year full-seasonal record of moths and beetles*. Journal of Animal Ecology. doi: 10.1111/1365-2656.12452.

Data for the 626 forest species **S2 Table**

Taxon	Species name	Threat geography	Redlist (	Decline?	Priority	Main affinity	Saproxylic?	Group	Zone	Forests (N)	Match	gap_Q?
Mammalia	Barbastella barbastellus	EU	VU	no	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Mammalia	Canis lupus	EU	-	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Mammalia	Eptesicus nilssonii	EU	NA	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Mammalia	Eptesicus serotinus	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	16		
Mammalia	Lepus europaeus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	321	82	
Mammalia	Martes martes	EU	NT	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	60		
Mammalia	Muscardinus avellanarius	EU	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	5	
Mammalia	Myotis bechsteinii	EU	DD	yes	A	Deciduous	Non-saproxylic	Open woodland	34	2	2	
Mammalia	Myotis brandtii	EU	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	6		
Mammalia	Myotis dasycneme	EU	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	3		
Mammalia	Myotis daubentonii	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	30		
Mammalia	Myotis mystacinus	EU	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	3		
Mammalia	Myotis nattereri	EU	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	14		
Mammalia	Nyctalus noctula	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	54		
Mammalia	Pipistrellus nathusii	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	19		
Mammalia	Pipistrellus pipistrellus	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	3		
Mammalia	Pipistrellus pygmaeus	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	39		
Mammalia	Plecotus auritus	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	8		
Aves	Aegolius funereus	EU	NA	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	20		
Aves	Bubo bubo	EU	NT	no	B	Deciduous	Non-saproxylic	Open woodland	3	22		
Aves	Caprimulgus europaeus	EU	LC	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	87		
Aves	Dryocopus martius	EU	LC	no	B	Deciduous	Non-saproxylic	Other decidous	34	113		
Aves	Falco subbuteo	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	22		
Aves	Ficedula parva	EU	NA	no	B	Deciduous	Non-saproxylic	Other decidous	34	35		
Aves	Grus grus	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	72		
Aves	Haliaeetus albicilla	EU	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	33		
Aves	Jynx torquilla	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	59	17	
Aves	Lanius collurio	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	201		
Aves	Lullula arborea	EU	NT	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	105		
Aves	Mergus merganser	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	22		
Aves	Nucifraga caryocatactes	Denmark	RE	RE	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	11	5	
Aves	Oriolus oriolus	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Other decidous	34	43	25	
Aves	Pernis apivorus	EU	LC	no	B	Deciduous	Non-saproxylic	Other decidous	34	94		
Aves	Serinus serinus	Denmark	VU	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	19		
Aves	Tringa ochropus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	40		
Amphibia	Hyla arborea	EU	LC	no	A	Deciduous	Non-saproxylic	Open woodland	3	40	9	
Amphibia	Rana arvalis	EU	LC	yes	A	Deciduous	Non-saproxylic	Open woodland	3	179	42	
Amphibia	Rana dalmatina	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	26		
Amphibia	Rana temporaria	EU	LC	no	B	Deciduous	Non-saproxylic	Open woodland	3	187		
Amphibia	Triturus cristatus	EU	LC	yes	A	Deciduous	Non-saproxylic	Open woodland	3	142	43	
Coleoptera	Allandrus undulatus	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Coleoptera	Allecula morio	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	3	1	0	gap1
Coleoptera	Ampedus hjorti	Globally	VU	no	A	Deciduous	Saproxylic	Open saproxylic	3	5	3	gap2
Coleoptera	Ampedus quercicola	Denmark	VU	no	B	Deciduous	Saproxylic	Open saproxylic	3	1		
Coleoptera	Ampedus sanguineus	Denmark	VU	no	B	Conifer obligate	Saproxylic	Conifer saproxylic	24	5		
Coleoptera	Carabus glabratus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	5	5	
Coleoptera	Carabus intricatus	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Coleoptera	Colydium elongatum	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	1	
Coleoptera	Crepidophorus mutilatus	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	3	5	3	gap2
Coleoptera	Cymindis vaporariorum	Denmark	VU	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	2	2	
Coleoptera	Dictyoptera aurora	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	2	
Coleoptera	Gnorimus nobilis	Denmark	CR	yes	A	Deciduous	Saproxylic	Open saproxylic	3	1	0	gap1
Coleoptera	Hallomenus axillaris	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	1	
Coleoptera	Hypulus quercinus	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	1	
Coleoptera	Ischnodes sanguinicollis	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	3	1	0	gap1
Coleoptera	Judolia sexmaculata	Denmark	EN	yes	A	Conifer obligate	Saproxylic	Conifer saproxylic	24	5	5	
Coleoptera	Labidostomis longimana	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Coleoptera	Lasiorhynchites cavifrons	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Coleoptera	Leptura aethiops	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	3	2	2	
Coleoptera	Lucanus cervus	Denmark	RE	RE	A	Deciduous	Saproxylic	Open saproxylic	3	2	0	gap2
Coleoptera	Lygistopterus sanguineus	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	2		
Coleoptera	Lymexylon navale	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	2	
Coleoptera	Magdalis armigera	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	34	3	3	
Coleoptera	Malachius aeneus	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	3	2	2	
Coleoptera	Melasis buprestoides	Denmark	EN	no	B	Deciduous	Saproxylic	Open saproxylic	3	3		
Coleoptera	Mycetophagus fulvicollis	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Coleoptera	Neomida haemorrhoidalis	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	1	
Coleoptera	Oberea linearis	Denmark	VU	no	B	Deciduous	Saproxylic	Open saproxylic	3	3		
Coleoptera	Omaloplia nigromarginata	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Coleoptera	Osmoderma eremita	EU	EN	yes	A	Deciduous	Saproxylic	Open saproxylic	3	1	1	
Coleoptera	Peltis ferruginea	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Coleoptera	Pissodes validirostris	Denmark	VU	no	B	Conifer obligate	Saproxylic	Conifer saproxylic	2	2		
Coleoptera	Plagionotus detritus	Denmark	RE	RE	A	Deciduous	Saproxylic	Woodland saprox	4	1	1	
Coleoptera	Pogonocherus decoratus	Denmark	EN	no	B	Conifer obligate	Saproxylic	Conifer saproxylic	24	2		
Coleoptera	Pyrrhidium sanguineum	Denmark	VU	no	B	Deciduous	Saproxylic	Open saproxylic	34	8		
Coleoptera	Pytho depressus	Denmark	VU	yes	A	Conifer obligate	Saproxylic	Conifer saproxylic	24	6	5	
Coleoptera	Rhynchaenus rufus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	2	
Coleoptera	Scolytus scolytus	Denmark	EN	yes	A	Deciduous	Saproxylic	Open saproxylic	34	1	1	
Coleoptera	Smaragdina salicina	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Coleoptera	Stictoleptura scutellata	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	12	4	gap1

Data for the 626 forest species **S2 Table**

Taxon	Species name	Threat geography	Redlist (	Decline?	Priority	Main affinity	Saproxylic?	Group	Zone	Forests (N)	Match	gap_Q?
Coleoptera	Tachyta nana	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	3	1	0	gap1
Coleoptera	Tetrops starkii	Denmark	VU	no	B	Deciduous	Saproxylic	Open saproxylic	34	1		
Coleoptera	Thymalus limbatus	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	3	3	
Coleoptera	Xylophilus corticalis	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	2	
Diptera	Arctophila bombiformis	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	6	5	
Diptera	Arctophila superbiens	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	24	10	
Diptera	Brachyopa bicolor	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	2	
Diptera	Brachyopa panzeri	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	8		
Diptera	Brachyopa scutellaris	Denmark	EN	yes	A	Deciduous	Saproxylic	Open saproxylic	34	1	1	
Diptera	Brachypalpus laphriformis	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	9	5	
Diptera	Caliprobola speciosa	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	1	gap1
Diptera	Chalcosyrphus piger	Denmark	VU	yes	A	Conifer obligate	Saproxylic	Conifer saproxylic	24	8	5	
Diptera	Chalcosyrphus valgus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	4	2	gap2
Diptera	Chamaesyrphus lusitanicus	Denmark	VU	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	1	1	
Diptera	Cheilosia flavipes	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	4		
Diptera	Cheilosia frontalis	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Diptera	Cheilosia illustrata	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	11	5	
Diptera	Chrysotoxum verralli	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	2	
Diptera	Criorhina floccosa	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	5	4	gap1
Diptera	Cyrtopogon lateralis	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	1	gap1
Diptera	Epistrophe grossulariae	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	2	gap2
Diptera	Epistrophe melanostoma	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Diptera	Eriozona syrphoides	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	13	5	
Diptera	Eumerus ornatus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	1	gap1
Diptera	Eumerus sogdianus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Diptera	Laphria ephippium	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	4	1	gap3
Diptera	Mallota cimbiciformis	Denmark	EN	yes	A	Deciduous	Saproxylic	Open saproxylic	34	6	6	
Diptera	Melangyna lucifera	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Diptera	Microdon analis	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	34	6	4	gap1
Diptera	Myolepta dubia	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	6	5	
Diptera	Pocota personata	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	3	3	
Diptera	Temnostoma meridionale	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	4	4	
Diptera	Trichopsomyia joratensis	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Diptera	Volucella inanis	Denmark	VU	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	3		
Diptera	Xanthogramma festivum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	3	gap2
Diptera	Xylota abiens	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	3	2	gap1
Diptera	Xylota meigeniana	Denmark	EN	yes	A	Deciduous	Saproxylic	Open saproxylic	34	2	2	
Heteroptera	Aradus betulae	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	34	6	6	
Heteroptera	Eurydema dominulus	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Heteroptera	Stagonomus bipunctatus	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	2	
Hymenoptera	Bombus veteranus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	5	
Hymenoptera	Formicoxenus nitidulus	Globally	VU	no	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	5	3	gap2
Lepidoptera	Acronicta cinerea	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	2	
Lepidoptera	Acronicta tridens	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	9	5	
Lepidoptera	Agrochola nitida	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	34	4	4	
Lepidoptera	Argynnis adippe	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	46	13	
Lepidoptera	Argynnis paphia	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	132	46	
Lepidoptera	Boloria euphrosyne	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	7	4	gap1
Lepidoptera	Brachionycha nubeculosa	Denmark	RE	RE	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Lepidoptera	Calliteara abietis	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	3	0	gap3
Lepidoptera	Coenonympha arcania	Denmark	RE	RE	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Lepidoptera	Cosmia affinis	Denmark	RE	RE	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Lepidoptera	Diarsia dahlii	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Lepidoptera	Drymonia obliterata	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Untouched decid	34	4	4	
Lepidoptera	Eilema griseola	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	17		
Lepidoptera	Eilema pygmaeola	Denmark	EN	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	4		
Lepidoptera	Endromis versicolora	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Lepidoptera	Eriogaster lanestris	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	8	5	
Lepidoptera	Herminia tarsicrinalis	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Lepidoptera	Lacanobia splendens	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	3	3	
Lepidoptera	Lasionhada proxima	Denmark	RE	RE	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	1	1	
Lepidoptera	Leptidea juvernica	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	2	
Lepidoptera	Leptidea sinapis	Denmark	RE	RE	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Lepidoptera	Malacosoma neustria	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	26	12	
Lepidoptera	Melitaea athalia	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	12	5	
Lepidoptera	Notodonta torva	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Lepidoptera	Nudaria mundana	Denmark	CR	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	4	3	gap1
Lepidoptera	Nymphalis polychloros	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	3	gap2
Lepidoptera	Pabulatrix pabulatricula	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Lepidoptera	Pachetra sagittigera	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	8	6	
Lepidoptera	Panemeria tenebrata	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	3		
Lepidoptera	Parasemia plantaginis	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	6	5	
Lepidoptera	Proserpinus proserpina	EU	NA	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Lepidoptera	Satyrium w-album	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	97	34	
Lepidoptera	Shargacucullia scrophulariae	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	13	6	
Lepidoptera	Thecla betulae	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	54	24	
Lepidoptera	Trichiura crataegi	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	13	7	
Lepidoptera	Xestia ditrapezium	Denmark	RE	RE	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Lepidoptera	Zygaena viciae	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	13	5	
Odonata	Leucorrhinia pectoralis	EU	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	22	6	

Data for the 626 forest species **S2 Table**

Taxon	Species name	Threat geography	Redlist (	Decline?	Priority	Main affinity	Saproxylic?	Group	Zone	Forests (N)	Match	gap_Q?
Orthoptera	Chorthippus dorsatus	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	1	gap3
Araneae	Araneus alsine	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	1	gap1
Araneae	Araneus angulatus	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	2	2	
Araneae	Araneus marmoreus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	9	5	
Araneae	Araneus triguttatus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Araneae	Dendryphantes rudis	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	1		
Araneae	Hygrolycosa rubrofasciata	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Araneae	Midia midas	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Gastropoda	Helix pomatia	EU	-	no	B	Deciduous	Non-saproxylic	Other decidous	34	101		
Gastropoda	Vertigo angustior	EU	-	yes	A	Deciduous	Non-saproxylic	Other decidous	34	16	6	
Gastropoda	Vertigo moulinsiana	Globally	VU	no	A	Deciduous	Non-saproxylic	Other decidous	34	19	11	
Pseudoscorpioı	Anthrenochernes stellae	EU	-	no	B	Deciduous	Saproxylic	Open saproxylic	34	2		
Ascomycota	Elaphomyces anthracinus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Ascomycota	Erythricium aurantiacum	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	4		
Ascomycota	Gyromitra gigas	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	3	1	gap2
Ascomycota	Helvella albella	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	3		
Ascomycota	Helvella costifera	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	34	1		
Ascomycota	Helvella queletii	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	8	6	
Ascomycota	Nemania carbonacea	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	5		
Ascomycota	Nemania diffusa	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	7		
Basidiomycota	Agaricus moelleri	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	4	6		
Basidiomycota	Agaricus phaeolepidotus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	34	3		
Basidiomycota	Agaricus porphyrizon	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	34	14		
Basidiomycota	Agrocybe firma	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Agrocybe vervacti	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	3		
Basidiomycota	Albatrellus pes-caprae	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Basidiomycota	Aleurodiscus disciformis	Denmark	CR	yes	A	Deciduous	Saproxylic	Woodland saprox	34	2	2	
Basidiomycota	Amanita lividopallescens	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Basidiomycota	Amanita olivaceogrisea	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	34	4		
Basidiomycota	Amanita solitaria	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Basidiomycota	Amanita strobiliformis	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	4		
Basidiomycota	Amaurodon cyaneus	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	34	1		
Basidiomycota	Anomoporia myceliosa	Denmark	EN	no	B	Conifer facultative	Saproxylic	Conifer saproxylic	24	3		
Basidiomycota	Antrodia heteromorpha	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Antrodia malicola	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	5		
Basidiomycota	Arrhenia epichysium	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	2		
Basidiomycota	Athelidium aurantiacum	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	1	
Basidiomycota	Aurantiporus alborubescens	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	9		
Basidiomycota	Aureoboletus gentilis	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	4		
Basidiomycota	Bankera fuligineoalba	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	8	5	
Basidiomycota	Bankera violascens	Denmark	CR	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	9	5	
Basidiomycota	Boletopsis leucomelaena	Denmark	CR	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	2		
Basidiomycota	Boletus aereus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	3		
Basidiomycota	Boletus fechtneri	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Boletus impolitus	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	4	
Basidiomycota	Boletus legaliae	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Boletus satanas	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Basidiomycota	Buchwaldoboletus lignicola	Denmark	CR	no	B	Conifer obligate	Saproxylic	Conifer saproxylic	24	7		
Basidiomycota	Buglossoporus quercinus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	34	2	2	
Basidiomycota	Calocera glossoides	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	3		
Basidiomycota	Camarophyllopsis atropuncta	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Basidiomycota	Camarophyllopsis hymenoceɼ	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	4		
Basidiomycota	Camarophyllopsis micacea	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Basidiomycota	Ceriporia purpurea	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	10		
Basidiomycota	Ceriporiopsis gilvescens	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	4	4	
Basidiomycota	Ceriporiopsis pannocincta	Denmark	RE	RE	A	Deciduous	Saproxylic	Woodland saprox	4	5	5	
Basidiomycota	Cerrena unicolor	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	10	5	
Basidiomycota	Chamaemyces fracidus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	4		
Basidiomycota	Cheimonophyllum candidissir	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	3		
Basidiomycota	Chromocyphella muscicola	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	34	1		
Basidiomycota	Clavaria asperulispora	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Basidiomycota	Clavaria flavipes	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	6	4	gap1
Basidiomycota	Clavaria tenuipes	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Basidiomycota	Clavicorona taxophila	Denmark	VU	no	B	Deciduous	Saproxylic	Open saproxylic	34	4		
Basidiomycota	Clavulinopsis cinereoides	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	7	5	
Basidiomycota	Clavulinopsis microspora	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	6		
Basidiomycota	Climacocystis borealis	Denmark	EN	yes	A	Conifer obligate	Saproxylic	Conifer saproxylic	24	10	8	
Basidiomycota	Clitocybe alexandri	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	5	5	
Basidiomycota	Coltricia confluens	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Basidiomycota	Conocybe dumetorum	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Coprinopsis insignis	Denmark	VU	no	B	Deciduous	Saproxylic	Open saproxylic	34	2		
Basidiomycota	Coprinopsis pannucioides	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	2		
Basidiomycota	Coprinopsis spelaiophila	Denmark	EN	no	B	Deciduous	Saproxylic	Open saproxylic	34	1		
Basidiomycota	Corticium expallens	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Cortinarius acetosus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	4		
Basidiomycota	Cortinarius arcuatorum	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius aureocalceolatus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius betulinus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Cortinarius bulliardii	Denmark	CR	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Cortinarius caesiocortinatus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	2		

Data for the 626 forest species **S2 Table**

Taxon	Species name	Threat geography	Redlist (	Decline?	Priority	Main affinity	Saproxylic?	Group	Zone	Forests (N)	Match	gap_Q?
Basidiomycota	Cortinarius caesiolatens	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	2		
Basidiomycota	Cortinarius caesiostramineus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius cagei	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Cortinarius camphoratus	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	8		
Basidiomycota	Cortinarius caperatus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	23	13	
Basidiomycota	Cortinarius catharinae	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius cinnabarinus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	20		
Basidiomycota	Cortinarius cisticola	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius colus	Denmark	RE	RE	A	Conifer obligate	Non-saproxylic	Conifer obligate	23	1	1	
Basidiomycota	Cortinarius cotoneus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	34	4		
Basidiomycota	Cortinarius elegantissimus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	34	5		
Basidiomycota	Cortinarius flavovirens	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius fragrantior	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Cortinarius fulvocitrinus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	2		
Basidiomycota	Cortinarius gracilior	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius imperialis	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius insignibulbus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius langeorum	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius lilacinovelatus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	34	2		
Basidiomycota	Cortinarius luteoimmarginatu	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius maculosus	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius magicus	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius multiformium	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	3		
Basidiomycota	Cortinarius nanceiensis	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius olearioides	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	34	3		
Basidiomycota	Cortinarius orellanus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	4		
Basidiomycota	Cortinarius osmophorus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	2		
Basidiomycota	Cortinarius porphyropus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Basidiomycota	Cortinarius quarciticus	Denmark	VU	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	2	3		
Basidiomycota	Cortinarius rufo-olivaceus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	34	6		
Basidiomycota	Cortinarius saporatus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius selandicus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius serratissimus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Cortinarius sodagnitus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius splendens	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius talus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	8		
Basidiomycota	Cortinarius tophaceus	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Basidiomycota	Cortinarius traganus	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	8	5	
Basidiomycota	Cortinarius urbicus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Cortinarius venustus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Cortinarius violaceocinereus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Cortinarius xanthochlorus	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Cortinarius xantho-ochraceus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	34	2		
Basidiomycota	Craterellus cinereus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	20	16	
Basidiomycota	Craterellus melanoxeros	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	4		
Basidiomycota	Crepidotus cinnabarinus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	0	gap1
Basidiomycota	Cristinia gallica	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	3		
Basidiomycota	Cystolepiota hetieri	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Untouched decid	4	5	5	
Basidiomycota	Cystolepiota icterina	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	4	2		
Basidiomycota	Cystolepiota moelleri	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	4	3		
Basidiomycota	Dacrymyces enatus	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	2		
Basidiomycota	Dendrocollybia racemosa	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	3		
Basidiomycota	Dendrothele commixta	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	34	8		
Basidiomycota	Dentipellis fragilis	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	2	
Basidiomycota	Dichomitus campestris	Denmark	RE	RE	A	Deciduous	Saproxylic	Woodland saprox	34	4	4	
Basidiomycota	Echinoderma calcicola	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	4	1		
Basidiomycota	Echinoderma hystrix	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	4	3		
Basidiomycota	Echinoderma perplexum	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	4	1		
Basidiomycota	Echinoderma pseudoasperulu	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	4	2		
Basidiomycota	Entoloma aprile	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	2	gap2
Basidiomycota	Entoloma clandestinum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	10	5	
Basidiomycota	Entoloma depluens	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	1	
Basidiomycota	Entoloma dichroum	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	3		
Basidiomycota	Entoloma formosum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	4	gap1
Basidiomycota	Entoloma lampropus	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	3	2	gap1
Basidiomycota	Entoloma lepidissimum	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	3		
Basidiomycota	Entoloma parkensis	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Entoloma placidum	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	6		
Basidiomycota	Entoloma plebejum	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	34	1		
Basidiomycota	Entoloma porphyrogriseum	Denmark	CR	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Basidiomycota	Entoloma queletii	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Untouched decid	4	2	0	gap2
Basidiomycota	Entoloma scabrosum	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	34	2	2	
Basidiomycota	Entoloma sinuatum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	3	3	
Basidiomycota	Entoloma strigosissimum	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	4	1		
Basidiomycota	Entoloma transvenosum	Denmark	CR	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Basidiomycota	Exidia cartilaginea	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	4	3	gap1
Basidiomycota	Faerberia carbonaria	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	3	1	1	
Basidiomycota	Femsjonia peziziformis	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Flammulaster limulatus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	4	3	gap1
Basidiomycota	Flammulaster muricata	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	6		

Data for the 626 forest species **S2 Table**

Taxon	Species name	Threat geography	Redlist (	Decline?	Priority	Main affinity	Saproxylic?	Group	Zone	Forests (N)	Match	gap_Q?
Basidiomycota	Fomitiporia robusta	Denmark	EN	no	B	Deciduous	Saproxylic	Open saproxylic	34	1		
Basidiomycota	Ganoderma resinaceum	Denmark	EN	no	B	Deciduous	Saproxylic	Open saproxylic	34	3		
Basidiomycota	Geastrum quadrifidum	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	2	2	
Basidiomycota	Gloeocystidiellum clavuligeru	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Gloeohypochnicium analogur	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	5		
Basidiomycota	Gloeoporus dichrous	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	5	2	gap3
Basidiomycota	Gomphus clavatus	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Basidiomycota	Gymnopus brassicolens	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	4	3		
Basidiomycota	Gymnopus hariolorum	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	4		
Basidiomycota	Gymnopus impudicus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Basidiomycota	Gymnopus inodorus	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	3		
Basidiomycota	Hebeloma fusisporum	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	5		
Basidiomycota	Hemipholiota heteroclita	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	5	4	gap1
Basidiomycota	Hericium cirrhatum	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	34	28	25	
Basidiomycota	Hericium erinaceus	Denmark	CR	yes	A	Deciduous	Saproxylic	Open saproxylic	34	8	7	
Basidiomycota	Hohenbuehelia atrocoerulea	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	2		
Basidiomycota	Hohenbuehelia auriscalpium	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	3	3	
Basidiomycota	Hohenbuehelia mastrucata	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	9		
Basidiomycota	Hohenbuehelia petaloides	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Basidiomycota	Hohenbuehelia unguicularis	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	1	
Basidiomycota	Hydnellum aurantiacum	Denmark	CR	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	8	6	
Basidiomycota	Hydnellum auratile	Denmark	CR	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Hydnellum caeruleum	Denmark	CR	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	9	7	
Basidiomycota	Hydnellum concrescens	Denmark	VU	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	24	17	
Basidiomycota	Hydnellum ferrugineum	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	10	5	
Basidiomycota	Hydnellum gracilipes	Denmark	CR	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	1		
Basidiomycota	Hydnellum peckii	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	7	5	
Basidiomycota	Hydnellum scrobiculatum	Denmark	RE	RE	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	1	1	
Basidiomycota	Hydnellum spongiosipes	Denmark	CR	no	B	Deciduous	Non-saproxylic	Other decidous	34	4		
Basidiomycota	Hydnum albidum	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	3		
Basidiomycota	Hydropus scabripes	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Hydropus trichoderma	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Hygrocybe quieta	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	10	6	
Basidiomycota	Hygrocybe vitellina	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	13	7	
Basidiomycota	Hygrophorus camarophyllus	Denmark	CR	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	1	1	
Basidiomycota	Hygrophorus lucorum	Denmark	CR	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	1		
Basidiomycota	Hygrophorus mesotephrus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Basidiomycota	Hygrophorus nemoreus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Hygrophorus persoonii	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	6		
Basidiomycota	Hyphoderma macedonicum	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	2		
Basidiomycota	Hyphoderma medioburiense	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	5	5	
Basidiomycota	Hypholoma ericaeum	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Basidiomycota	Hypsizygus ulmarius	Denmark	EN	yes	A	Deciduous	Saproxylic	Open saproxylic	34	1	1	
Basidiomycota	Inocybe calamistrata	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Basidiomycota	Inocybe flavella	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	4		
Basidiomycota	Inocybe huijsmanii	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Inocybe hystrix	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Inocybe margaritispora	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Inocybe quietiodor	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Inocybe sambucina	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	2	1	gap1
Basidiomycota	Inocybe tenebrosa	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Inonotus dryadeus	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	34	9	6	
Basidiomycota	Inonotus hispidus	Denmark	VU	no	B	Deciduous	Saproxylic	Open saproxylic	34	1		
Basidiomycota	Ischnoderma resinosum	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	28		
Basidiomycota	Kavinia himantia	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Lactarius acerrimus	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	6	5	
Basidiomycota	Lactarius albocarneus	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	7	2	gap3
Basidiomycota	Lactarius azonites	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	7		
Basidiomycota	Lactarius decipiens	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Basidiomycota	Lactarius evosmus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	34	1		
Basidiomycota	Lactarius hysginus	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	2	1	gap1
Basidiomycota	Lactarius lignyotus	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	4		
Basidiomycota	Lactarius mammosus	Denmark	VU	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	2	6		
Basidiomycota	Lactarius musteus	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	4		
Basidiomycota	Lactarius porninsis	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	7		
Basidiomycota	Lactarius repraesentaneus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	8	5	
Basidiomycota	Lactarius scrobiculatus	Denmark	EN	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	24	1		
Basidiomycota	Lactarius uvidus	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	5	5	
Basidiomycota	Lactarius violascens	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Basidiomycota	Lactarius volemus	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	32	12	
Basidiomycota	Leccinum crocipodium	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	4		
Basidiomycota	Lentaria byssiseda	Denmark	VU	no	B	Deciduous	Saproxylic	Open saproxylic	34	5		
Basidiomycota	Lentaria epichnoa	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	1	
Basidiomycota	Lentinellus ursinus	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	18		
Basidiomycota	Lentinus suavissimus	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Lepiota cingulum	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	4	1		
Basidiomycota	Lepiota echinella	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	34	7		
Basidiomycota	Lepiota fuscovinacea	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	4	5		
Basidiomycota	Lepiota grangei	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Untouched decid	4	9	5	
Basidiomycota	Lepiota griseovirens	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	34	3		

Data for the 626 forest species **S2 Table**

Taxon	Species name	Threat geography	Redlist (	Decline?	Priority	Main affinity	Saproxylic?	Group	Zone	Forests (N)	Match	gap_Q?
Basidiomycota	Lepiota ignivolvata	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Basidiomycota	Lepiota ochraceofulva	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	4	4		
Basidiomycota	Lepiota poliochloodes	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	4	2		
Basidiomycota	Lepiota pseudolilacea	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	6		
Basidiomycota	Lepiota subgracilis	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	4	5		
Basidiomycota	Leucoagaricus badhamii	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	4	1		
Basidiomycota	Leucocoprinus brebissonii	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	4	5		
Basidiomycota	Leucopaxillus compactus	Denmark	CR	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Lichenomphalia hudsoniana	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	34	1	1	
Basidiomycota	Lindtneria trachyspora	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	2		
Basidiomycota	Lycoperdon mammiforme	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Basidiomycota	Lyophyllum deliberatum	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	3		
Basidiomycota	Lyophyllum eustygium	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Lyophyllum leucophaeatum	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	4	4	
Basidiomycota	Lyophyllum semitale	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	8	5	
Basidiomycota	Mycena clavata	Denmark	VU	no	B	Conifer obligate	Saproxylic	Conifer saproxylic	24	11		
Basidiomycota	Mycena leptophylla	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	5		
Basidiomycota	Ossicaulis lignatilis	Denmark	VU	no	B	Deciduous	Saproxylic	Open saproxylic	34	4		
Basidiomycota	Pachykytospora tuberculosa	Denmark	CR	yes	A	Deciduous	Saproxylic	Woodland saprox	34	2	2	
Basidiomycota	Perenniporia fraxinea	Denmark	CR	yes	A	Deciduous	Saproxylic	Open saproxylic	34	1	1	
Basidiomycota	Phaeocollybia arduennensis	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	1		
Basidiomycota	Phaeocollybia christinae	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	1		
Basidiomycota	Phaeocollybia lugubris	Denmark	EN	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	2		
Basidiomycota	Phellinus laevigatus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	1	gap1
Basidiomycota	Phellodon confluens	Denmark	EN	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	7		
Basidiomycota	Phellodon melaleucus	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	31	23	
Basidiomycota	Phellodon niger	Denmark	VU	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	15	13	
Basidiomycota	Phellodon tomentosus	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	17	10	
Basidiomycota	Phlebia subserialis	Denmark	VU	no	B	Conifer facultative	Saproxylic	Conifer saproxylic	24	1		
Basidiomycota	Pholiota squarrosoides	Denmark	CR	no	B	Deciduous	Saproxylic	Woodland saprox	34	1		
Basidiomycota	Pholiota tuberculosa	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	34	10	7	
Basidiomycota	Phylloporus pelletieri	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	11	9	
Basidiomycota	Pisolithus arrhizus	Denmark	VU	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	1		
Basidiomycota	Pluteus atromarginatus	Denmark	VU	yes	A	Conifer obligate	Saproxylic	Conifer saproxylic	24	9	5	
Basidiomycota	Pluteus aurantiorugosus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	34	1	1	
Basidiomycota	Pluteus exiguus	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	3		
Basidiomycota	Pluteus hispidulus	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	5		
Basidiomycota	Pluteus insidiosus	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	3		
Basidiomycota	Pluteus leoninus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	9	5	
Basidiomycota	Pluteus pellitus	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	34	9	9	
Basidiomycota	Pluteus roseipes	Denmark	EN	no	B	Conifer obligate	Saproxylic	Conifer saproxylic	24	1		
Basidiomycota	Polyporus melanopus	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	5	4	gap1
Basidiomycota	Porodaedalea pini	Denmark	VU	yes	A	Conifer obligate	Saproxylic	Conifer saproxylic	24	7	5	
Basidiomycota	Porotheleum fimbriatum	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	3		
Basidiomycota	Porpoloma metapodium	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	34	5	5	
Basidiomycota	Psathyrella caput-medusae	Denmark	CR	yes	A	Conifer obligate	Saproxylic	Conifer saproxylic	24	2	2	
Basidiomycota	Psathyrella leucotephra	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	3	3	
Basidiomycota	Psathyrella spintrigeroides	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	3		
Basidiomycota	Psathyrella suavissima	Denmark	EN	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	1		
Basidiomycota	Pycnoporellus fulgens	Denmark	EN	no	B	Conifer obligate	Saproxylic	Conifer saproxylic	24	20		
Basidiomycota	Ramaria botrytis	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	18	15	
Basidiomycota	Ramaria fagetorum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	8	7	
Basidiomycota	Ramaria fennica	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	1	gap1
Basidiomycota	Ramaria flavescens	Denmark	CR	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Ramaria formosa	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	4	4	
Basidiomycota	Ramaria kriegIsteineri	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	34	5		
Basidiomycota	Ramaria largentii	Denmark	CR	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Ramaria pallida	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	11	8	
Basidiomycota	Ramaria sanguinea	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	15	10	
Basidiomycota	Ramaria suecica	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	6		
Basidiomycota	Ramariopsis pulchella	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	34	3		
Basidiomycota	Rhizomarasmius undatus	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Rhodocollybia prolixa	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	4		
Basidiomycota	Rhodocybe hirneola	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Basidiomycota	Rhodocybe melleopallens	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	4	2		
Basidiomycota	Rhodocybe nitellina	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	4	2	2	
Basidiomycota	Rugosomyces cerinus	Denmark	VU	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	4		
Basidiomycota	Rugosomyces chrysenteron	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	2	1	gap1
Basidiomycota	Rugosomyces ionides	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	7	5	
Basidiomycota	Rugosomyces obscurissimus	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	3		
Basidiomycota	Russula albonigra	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Untouched decid	34	9	7	
Basidiomycota	Russula anthracina	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	12		
Basidiomycota	Russula caerulea	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	9	5	
Basidiomycota	Russula carpini	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Basidiomycota	Russula decipiens	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Russula emeticicolor	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	7		
Basidiomycota	Russula fragrantissima	Denmark	CR	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Basidiomycota	Russula helodes	Denmark	EN	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	7		
Basidiomycota	Russula innocua	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Basidiomycota	Russula integra	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	3		

Data for the 626 forest species **S2 Table**

Taxon	Species name	Threat geography	Redlist (	Decline?	Priority	Main affinity	Saproxylic?	Group	Zone	Forests (N)	Match	gap_Q?
Basidiomycota	Russula laeta	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	6		
Basidiomycota	Russula lilacea	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	8		
Basidiomycota	Russula melliolens	Denmark	EN	no	B	Deciduous	Non-saproxylic	Other decidous	34	9		
Basidiomycota	Russula mustelina	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	3		
Basidiomycota	Russula pallidospora	Denmark	CR	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Russula pelargonia	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	9		
Basidiomycota	Russula persicina	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Basidiomycota	Russula puellula	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	6		
Basidiomycota	Russula rhodopus	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	4	3	gap1
Basidiomycota	Russula roseoaurantia	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	34	7		
Basidiomycota	Russula sanguinea	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	16		
Basidiomycota	Russula torulosa	Denmark	EN	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	1		
Basidiomycota	Russula turci	Denmark	VU	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	6		
Basidiomycota	Russula zonatula	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Sarcodon imbricatus	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	17	6	
Basidiomycota	Sarcodon lepidus	Denmark	CR	no	B	Deciduous	Non-saproxylic	Other decidous	34	2		
Basidiomycota	Sarcodon scabrosus	Denmark	CR	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	4	3	gap1
Basidiomycota	Sarcodon squamosus	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	22	12	
Basidiomycota	Simocybe sumptuosa	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	4		
Basidiomycota	Spongipellis delectans	Denmark	CR	no	B	Deciduous	Saproxylic	Woodland saprox	34	7		
Basidiomycota	Spongipellis fissilis	Denmark	EN	yes	A	Deciduous	Saproxylic	Open saproxylic	34	6	5	
Basidiomycota	Steccherinum litschaueri	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	2		
Basidiomycota	Steccherinum subcrinale	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	1	
Basidiomycota	Stypella dubia	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Stypella subgelatinosa	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	7		
Basidiomycota	Suillus placidus	Denmark	CR	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	1		
Basidiomycota	Tomentella crinalis	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	3		
Basidiomycota	Tomentella italica	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Tomentella lateritia	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	3	1	gap2
Basidiomycota	Tomentella pilosa	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	2		
Basidiomycota	Tomentella umbrinospora	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	9		
Basidiomycota	Trametes suaveolens	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	1	gap1
Basidiomycota	Trechispora silvae-ryae	Denmark	VU	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Tremellodendropsis tuberosa	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	9	8	
Basidiomycota	Tricholoma apium	Denmark	EN	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	7		
Basidiomycota	Tricholoma arvernense	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	11	7	
Basidiomycota	Tricholoma aurantium	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	6	3	gap2
Basidiomycota	Tricholoma basirubens	Denmark	CR	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Basidiomycota	Tricholoma columbetta	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	26	20	
Basidiomycota	Tricholoma focale	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	14	6	
Basidiomycota	Tricholoma inamoenum	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	3	1	gap2
Basidiomycota	Tricholoma matsutake	Denmark	EN	no	B	Conifer obligate	Non-saproxylic	Conifer obligate	2	5		
Basidiomycota	Tricholoma sejunctum	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	5	5	
Basidiomycota	Tricholoma sudum	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	10	6	
Basidiomycota	Tricholoma ustaloides	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	3		
Basidiomycota	Tulostoma fimbriatum	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Basidiomycota	Volvariella caesiotincta	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	4		
Basidiomycota	Volvariella hypopithys	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	4	4		
Basidiomycota	Volvariella murinella	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	34	4	4	
Basidiomycota	Volvariella surrecta	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	10		
Basidiomycota	Xenasma pulverulentum	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	4	1		
Basidiomycota	Xerula caussei	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Basidiomycota	Xerula longipes	Denmark	EN	no	B	Deciduous	Saproxylic	Woodland saprox	34	3		
Basidiomycota	Xylobolus frustulatus	Denmark	CR	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	1	gap1
Lichen	Anisomeridium biforme	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Lichen	Anisomeridium polypori	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Lichen	Arthonia radiata	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	17	14	
Lichen	Baeomyces placophyllus	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	1	1	
Lichen	Caloplaca cerina	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Lichen	Cladonia carneola	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	1	1	
Lichen	Cladonia cenotea	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	2	
Lichen	Cladonia floerkeana	Denmark	VU	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	50	32	
Lichen	Cladonia glauca	Denmark	VU	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	26	17	
Lichen	Cladonia incrassata	Denmark	CR	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	1	0	gap1
Lichen	Cladonia novochlorophaea	Denmark	VU	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	3	2	gap1
Lichen	Cladonia portentosa	EU	LC	yes	B	Deciduous	Non-saproxylic	Open woodland	3	65		
Lichen	Cladonia ramulosa	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	38	22	
Lichen	Cladonia rangiferina	EU	LC	yes	B	Deciduous	Non-saproxylic	Open woodland	3	15		
Lichen	Cladonia squamosa	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	13	5	
Lichen	Cladonia sulphurina	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	4	gap1
Lichen	Dibaeis baeomyces	Denmark	CR	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Lichen	Fuscidea cyathoides	Denmark	VU	no	B	Deciduous	Non-saproxylic	Other decidous	34	1		
Lichen	Gyalecta flotowii	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Lichen	Haematomma ochroleucum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	10	8	
Lichen	Lecanactis abietina	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Other decidous	34	17	13	
Lichen	Lecania naegelii	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Lichen	Lecanora argentata	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	4	4	
Lichen	Lecanora glabrata	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Lichen	Lecanora intumescens	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	4	4	
Lichen	Lecanora pulicaris	Denmark	VU	yes	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	16	10	

Data for the 626 forest species **S2 Table**

Taxon	Species name	Threat geography	Redlist (	Decline?	Priority	Main affinity	Saproxylic?	Group	Zone	Forests (N)	Match	gap_Q?
Lichen	Lecanora symmicta	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	13	6	
Lichen	Lecanora varia	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	3	3	
Lichen	Lobaria pulmonaria	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	18	12	
Lichen	Melanohalea elegantula	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	0	gap2
Lichen	Mycocalicium subtile	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Lichen	Nephroma laevigatum	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Lichen	Ochrolechia androgyna	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	2	
Lichen	Ochrolechia pallescens	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Lichen	Ochrolechia subviridis	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Lichen	Ochrolechia turneri	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	4	4	
Lichen	Opegrapha herbarum	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	3	3	
Lichen	Opegrapha varia	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Lichen	Opegrapha vermicellifera	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	15	8	
Lichen	Opegrapha viridis	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Lichen	Opegrapha vulgata	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Lichen	Pachyphiale carneola	Denmark	RE	RE	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Lichen	Peltigera praetextata	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	8	5	
Lichen	Pertusaria amara	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	26	15	
Lichen	Pertusaria coccodes	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Lichen	Pertusaria hemisphaerica	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	2	
Lichen	Pertusaria leioplaca	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Lichen	Porina aenea	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	11	11	
Lichen	Pyrenula chlorospila	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Lichen	Pyrenula nitida	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	24	18	
Lichen	Pyrrhospora quernea	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	
Lichen	Ramalina calicaris	Denmark	RE	RE	A	Conifer facultative	Non-saproxylic	Conifer facultativ	23	1	1	
Lichen	Thelotrema lepadinum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	24	17	
Lichen	Trapeliopsis gelatinosa	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	2	
Lichen	Usnea filipendula	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	23	8	6	
Lichen	Usnea genus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Lichen	Usnea hirta	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	10	7	
Lichen	Usnea subfloridana	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	15	7	
Lichen	Xanthomendoza poeltii	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Bryophyta	Buxbaumia viridis	EU	-	no	A	Deciduous	Non-saproxylic	Other decidous	34	14	7	
Bryophyta	Leucobryum glaucum	EU	-	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	42		
Bryophyta	Sphagnum fallax	EU	-	unknowr	B	Deciduous	Non-saproxylic	Other decidous	34	49		
Bryophyta	Sphagnum fimbriatum	EU	-	unknowr	B	Deciduous	Non-saproxylic	Other decidous	34	51		
Bryophyta	Sphagnum palustre	EU	-	unknowr	B	Deciduous	Non-saproxylic	Other decidous	34	60		
Bryophyta	Sphagnum squarrosum	EU	-	unknowr	B	Deciduous	Non-saproxylic	Other decidous	34	48		
Bryophyta	Sphagnum teres	EU	-	unknowr	B	Deciduous	Non-saproxylic	Other decidous	34	20		
Tracheophyta	Asplenium scolopendrium	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	3		
Tracheophyta	Bromus racemosus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	3	2	gap1
Tracheophyta	Cephalanthera longifolia	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	2		
Tracheophyta	Cephalanthera rubra	Denmark	EN	no	B	Deciduous	Non-saproxylic	Untouched decid	34	2		
Tracheophyta	Cypripedium calceolus	EU	VU	no	A	Deciduous	Non-saproxylic	Open woodland	3	2	1	gap1
Tracheophyta	Dianthus armeria	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Tracheophyta	Diphasiastrum complanatum	EU	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Tracheophyta	Diphasiastrum tristachyum	EU	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	11	5	
Tracheophyta	Epipactis atrorubens	Denmark	VU	no	B	Deciduous	Non-saproxylic	Open woodland	3	2		
Tracheophyta	Epipactis leptochila	Denmark	VU	no	B	Deciduous	Non-saproxylic	Untouched decid	34	1		
Tracheophyta	Galium valdepilosum	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Other decidous	34	1	1	
Tracheophyta	Huperzia selago	EU	LC	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	38		
Tracheophyta	Laserpitium latifolium	Denmark	EN	no	B	Deciduous	Non-saproxylic	Open woodland	3	1		
Tracheophyta	Lycopodium annotinum	EU	LC	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	65		
Tracheophyta	Lycopodium clavatum	EU	LC	no	B	Conifer facultative	Non-saproxylic	Conifer facultativ	23	67		
Tracheophyta	Melampyrum cristatum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Tracheophyta	Melampyrum nemorosum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	1	gap1
Tracheophyta	Ophrys insectifera	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Tracheophyta	Pilosella cymosa	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Tracheophyta	Platanthera bifolia ssp. latiflo	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	34	1	1	
Tracheophyta	Poa supina	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	3	3	
Tracheophyta	Pulmonaria officinalis	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	2	gap2
Tracheophyta	Sorbus hybrida	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	4	gap1
Tracheophyta	Ulmus laevis	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	1	
Tracheophyta	Viola epipsila	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	0	gap2
Tracheophyta	Viola mirabilis	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	2	

S2 Table. Species data. Details of status, preferences and zones for the 626 forest species.

Threat geography: Most of the internationally threatened species are also threatened at national level, but only the most international threat listing is shown

Redlist: Global category if globally threatened. Danish redlist category otherwise (never EU category).

Decline: According to redlist information (for reasons of consistency not according to EU reports).

Zone: The species affinity or preference for one or more of the defined managemenet types (z1= Normal, z2 = Conifer, z3 = Active, z4 = Untouched).

Forests: The number of State Forests in Denmark with occurrence of the species recorded 1991-2015.

Match: The number of State Forests put in a matching zone for the species by scenario Q. (Only noted for priority A species).

gap_Q?: Gap between target (5 representations or 100%) and matches in scenario Q.

Forests a priori locked to zone 4 (Untouched)

S3 Table

		Area (ha)				% wood already in		MX zones	Number of species from each zone group								Priority A species		% of obs already	
Dist	Forest name	Decid	Conif	Unwood	Total	zone 3	zone 4	chosen	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
SHL	Velling Skov	103	186	47	335	27	62	1 4		7	3	3		8	6	27	13	8	19	65
SHL	Vorsø mm.	17		45	62		100	1 4		8		1		2	6	17	10	5		100
VAD	Draved Skov og Kongens Mose	198	1	366	565		100	4		16	10	5		14	31	76	32	19		44
FYN	Kasmose Skov	11		9	20		100	3 4		3	2			10	1	16	5	5	19	20
SDJ	Midtskov	5	0	0	5		100	1 4								none				
SDJ	Rønhave Skov	5			5		100	1 4								none				
SDJ	Bolderslev Skov	109	2	46	157		100	1 3 4		5		2		2	2	11	4	4		100

Criteria for a priori locking to zone 4 (Untouched):

Either 100 % of total area untouched already AND > 5 wooded hectares untouched
Or > 100 hectares woodland untouched AND > 45% of total area untouched

Already untouched includes conifer areas of Velling Forest decided in 1994 to be included as untouched after a transition period removing conifers.

Forests always in zone 4 (N = 20)

S4 Table

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Dist	Forest name	Area (ha) Decid	Conif	Unwood	Total	% already in zone 3	zone 4	MX zones chosen	Number of species from each zone group z2	z3	z4	z23	z24	z34	non-forest	Total	Priority A species All	Forest	% of obs already in z3	in z4
HIM	Nørreskov	181	227	64	472	20	10	4	2	14	13	4	2	42	6	83	42	38	41	35
SHL	Dalgård	14	12	31	56			4		6	1	2		1	12	22	17	8		
SHL	Klostermølle mm.	6	7	47	60		6	4		7	1	2		5	8	23	13	8		11
KJY	Ajstrup Strand	13		10	22	56		4			1			1	1	3	2	1	67	
VAD	Draved Skov og Konge	198	1	366	565	1	46	4		16	10	5		14	31	76	32	19		44
SDJ	Søgård Skov	88	55	17	160	4	4	4		4	1	1		3	1	10	5	4	2	
STS	Klinteskov	250	2	286	538	39	24	4	1	33	32	12		55	46	179	90	53	33	37
HST	Ravneholmene	68	14	47	129	18		4		2	6	1	2	2	3	16	10	8	47	
HST	Jægersborg Dyrehave	435	8	452	895	87	3	4	1	30	30	7	1	47	31	147	83	58	87	7
HST	Ordrup Krat	17		38	55			4		1	3			4	3	11	8	6		
NSJ	Arresødal skov	63	7	15	85	61	12	4		5	7	1		4	2	19	7	6	17	43
NSJ	Esrum Møllegård	2		50	52			4		3	1			1		5	3	3		
NSJ	Gribskov	1943	1180	722	3845	11	8	4	7	28	19	16	5	45	43	163	89	70	16	26
NSJ	Søskoven	498	188	100	785	37	6	4	1	13	4	6	2	24	8	58	23	21	27	8
NSJ	Store Dyrehave	614	352	121	1087	0	1	4	1	7	10	4	3	17	12	54	23	18	2	5
NSJ	Harager Hegn	259	50	51	359	2	8	4		6	2	3	1	8	4	24	12	9		31
NSJ	Horserød Hegn	381	166	70	616	6	13	4	1	3	5	2	1	13	11	36	12	11	6	15
NSJ	Gurre Vang	146	38	258	442	9	15	4		11	2	2	1	8	13	37	9	7	26	19
OSJ	Farum Lillevang	87	7	12	106	5	2	4		3	4			5	4	16	6	3	6	46
OSJ	Store Hareskov	181	69	45	295	5		4	1	10	6	2		12	3	34	15	13		
	total	5442	2382	2802	10625															

Forests always in zone 3 (N = 55) **S5 Table**

		Area (ha)				% already in		MX zones	Number of species from each zone group								Priority A species		% of obs already	
Dist	Forest name	Decid	Conif	Unwood	Total	zone 3	zone 4	chosen	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
HIM	Gravlev ådal	4	1	114	119			3		9				1	11	21	9	4		
HIM	Navn Sø			100	100			3		5				4	15	24	12	4		
HIM	Rebild Bakker	1		107	108	100		3	1	6		1	1	1	8	18	10	5	100	
VJY	Tihøje Hede	6		210	217			3		1		1			1	3	2	1		
SHL	Østerskoven, østlige d	92	138	149	379	20	10	3	2	4		4		8	3	21	11	9	10	11
SHL	Bjørnholt	11	25	31	66	2		3	1	6					10	17	15	5		
SHL	Hulbakken		2	6	8			3		1		1				2	1	1		
THY	Hvidbjerg Plantage	108	740	835	1682		6	3	2	6		5		1	23	37	26	9		5
THY	Svinkløv Plantage	132	332	253	717			3	5	13	3	5	1	2	15	44	28	16		
KJY	Mols Bjerge	60	60	715	836	8	3	3	2	25	1	6	2	13	59	108	80	28	3	14
KJY	Hestehave Skov	126	36	51	213	1	4	3		7		3		24	23	57	45	23		8
KJY	Kalø Hovedgård		1	7	7			3		4				2	3	9	9	6		
MJY	Nørlund Plantage	112	1435	1435	2982			3	14	13		14		9	57	107	62	24		
VAD	Årup Hede			39	39			3		3		3			6	12	9	5		
VAD	Rømø Strand		2	4171	4173			3		5					26	31	19	4		
FYN	Bobakkerne			62	62			3		6					22	28	26	6		
FYN	Sollerup Skov	85	31	73	189		0	3		6	1			4	2	13	4	3		
FYN	Svanninge Bakker	51	16	254	320	0		3	1	11	2	3		4	9	30	23	14		
FYN	Rødme Svinehaver	10	1	25	36			3		6				2	10	18	10	4		
FYN	Thurø Rev			36	36			3		7					13	20	18	6		
FYN	Voderup Klint			35	35			3		7				1	8	16	12	6		
FYN	Lille Rise	2	6	2	9			3		1						1	1	1		
BLH	Skallingen			2003	2003			3		5		2			30	37	28	5		
BLH	Fanø Plantage	54	620	580	1254			3	1	9		3		4	22	39	20	7		
TRE	Skærsø	7	1	5	12			3		1				1	4	6	5	1		
TRE	Skovhave M.M.	2		15	17		9	3		2					2	4	4	2		
TRE	Ussinggård Sønder og	47	24	2	74			3		2					2	4	2	2		
TRE	Drenderup Skov	37	7	1	45			3		4						4	3	3		
TRE	Svanemosen	34	2	88	124	21	27	3		14	1	8		5	20	48	20	12	57	11
TRE	Østergård	7	1	94	102		8	3		3					3	6	5	3		
SDJ	Sønderskov	278	54	77	409	0	0	3		15	1	1		2	6	25	14	10		
SDJ	Rise Skov	90	3	31	124	3	5	3		3		1			2	6	3	2		
SDJ	Kalvø mv.	11		31	42	7	8	3		1		1		1	2	5	2	1		
STS	Hannenov Skov	144	80	89	314			3		13		1		5	9	28	14	9		
STS	Halskov Vænge	16	1	26	44	41	20	3		4						4	2	2	100	
STS	Holtug Kalkbrud			6	6			3		6		1			7	14	12	6		
BON	Almindingen	916	1097	406	2420	3	3	3	9	29	4	2	2	22	48	116	63	34	6	3
BON	Ølene	13	6	76	95	17	23	3	4	18		2		8	19	51	28	16		5
BON	Hammersholm og Har	38		169	207	15		3		17				4	35	56	48	17	6	
BON	Slotslyngen	83	12	67	162	28	30	3	1	16		4		15	25	61	43	25	37	44
BON	Borrelyngen	6	1	32	38	55	12	3	1	6		1		3	10	21	14	5	99	
HST	Strandparken	13	1	45	58			3		9	1	1		13	3	27	12	10		
HST	Kalvebod Fælled	28	0	153	182			3		2					9	11	7	2		
VSJ	Kongsøre Skov	183	29	35	247	1	1	3		5				3	1	9	6	6		
VSJ	Sonnerup Skov	66	173	49	287			3	2	9					13	24	21	9		
NSJ	Vinderød skov	32	8	28	68	19		3		7				1	2	10	8	6	89	
NSJ	Lyngby skov	51	7	9	66			3		4				3	1	8	6	5		
NSJ	Ll. lyngby mose	2	2	46	50			3	1	8	1			1	13	24	16	7		
NSJ	Grønnæsse skov	68	25	7	100			3		7				2		9	6	6		
NSJ	Præstevang	82	5	13	100	1	2	3		2				2	1	5	4	3		
NSJ	Hellebæk Skov	171	12	221	403	12	7	3		16	3	1		7	12	39	20	14	15	18
NSJ	Egebæksvang Skov	93	1	25	119	2		3		6	3			3	2	14	9	7		
NSJ	Fredensborg Skovene	10	2	0	12	88		3						2		2	1	1	100	
OSJ	Tokkekøb Hegn	409	108	113	630	7	3	3		12		5		12	4	33	22	20		7
OSJ	Ganløse Eged m.m.	129	22	16	167		2	3		10	1			2	9	22	16	8		1
	total	3918	5126	13266	22310															

Forests with zone variability (N = 220) **S6 Table**

Dist	Forest name	Area (ha) Decid	Conif	Jnwood	Total	% already in z3	% already in z4	MX zones chosen	Number of species from each zone group z2	z3	z4	z23	z24	z34	non-forest	Total	Priority A species All	Forest	% of obs already in z3	in z4	MX zone result O3	Q5
HIM	Skindbjerglund	37	1	12	50	82	12	3 4		9	5	2	1	9	1	27	19	18	75	25	4	3
HIM	Præstens Plantage		17	4	21			1 2	1							1	1	1			1	1
HIM	Smidie Kalkgruber			1	1			1 3		2						2					1	1
HIM	Vilsted Sø	13		848	861		2	1 3		3					11	14	6	1		8	1	1
HIM	Fællesskov	187	307	98	592	32	8	2 3 4	1	6	3	1		10	3	24	17	14	38	27	2	3
HIM	Livø	41	20	273	334	14	11	3 4		8			1	7	11	27	16	7	43		3	3
VJY	Klosterheden Plantag	847	4462	1090	6399		2	1 2 3	4	10		7		2	29	52	34	11		3	1	3
VJY	Stråsø Plantage	216	760	942	1917		1	1 2	14	8		12	1	2	20	57	41	23		1	2	2
VJY	Arealer ved Ferring o			73	73			1 3		1					4	5	5	1			3	3
VJY	Harboøre Tange			1114	1114			1 3		4					17	21	13	3			3	3
VJY	Hoverdal Plantage	115	1039	408	1562			2 3 4	12	10	2	9	1	9	30	73	43	22			2	3
VJY	Fejsø Plantage	200	658	731	1588		3	1 2 3	12	5		6			10	33	22	13		13	1	2
VJY	Husby Plantage	100	710	256	1066			1 2	2	7		4	1		17	31	22	10			1	2
VJY	Arealer i Ringkøbing k			7	7			1 3		2					4	6	4	1			1	3
VJY	Fjand Enge		4	253	257			1 3		2					9	11	8	1			1	3
VJY	Vest Stadil Fjord			1108	1108			1 3		5				1	21	27	17	3			3	3
VJY	Blåbjerg Plantage	91	337	375	802		1	1 3		3		4		1	7	15	8	3			1	1
VJY	Sandfær	20	21	529	569		1	1 3	1	7		6			9	23	14	6		4	1	3
SHL	Kobskov Øst	17	21	42	80			3 4				2		3	1	6	5	4			3	3
SHL	Nordskov	191	607	188	986	17	11	2 3	20	8	2	12	2	16	16	76	55	41	13	35	2	2
SHL	Snabegård Skov	27	88	20	135	10	0	1 3		4		3		6	8	21	10	7	28		1	1
SHL	Velling Skov	103	186	47	335	23	54	1 4		7	3	3		8	6	27	13	8	19	65	4	4
SHL	Vorsø mm.	17		45	62		77	1 4		8		1		2	6	17	10	5		100	4	4
SHL	Trustrup Høje	0	2	6	8			1 3		1					1	2	2	1			1	3
SHL	Naturstien Stenballe S			9	9			1 3 4			1			6		7	1	1			1	1
SHL	Thorsø Bakker	31	107	34	171	9	9	1 2	1					4	1	6	1	1	6	17	1	1
SHL	Sønderskov	250	205	229	684	35	3	3 4	1	2	2	4		17	6	32	18	13	59	8	3	3
SHL	Himmelbjerget	49	92	13	154			1 3		1		2		1	2	6	4	3			1	1
SHL	Høgdal	18	12	24	53	8	2	1 3		7				2	15	24	22	8	70		3	3
SHL	Kallehave	3	21	16	39			1 3		2					6	8	7	2			1	3
SHL	Odderholm	2	1	24	27			2 4	1	12	1	5		5	20	44	28	13			2	4
SHL	Mariedal	0	8	33	40			1 3		1					2	3	3	1			1	1
SHL	Ny Vissingkloster	24	26	39	89			1 3		6				1	9	16	14	5			1	3
SHL	Lysbro Skov	39	43	67	149	7	14	3 4	2	4	1			3	5	15	8	5		13	3	4
SHL	Vesterskov	184	375	94	653	29	27	3 4	3	6	7	7		16	9	48	23	18	21	40	3	4
SHL	Gjern Bakker	22	2	9	33	69	14	1 3		3					2	5	4	2	80		1	3
SHL	Kobskov Vest	19	4	55	77	14		3 4	1	1	1	3		9	1	16	8	7	18		3	3
VSY	Læsø Plantage	375	786	714	1875	9	2	3 4	9	11	2	8		8	38	76	42	19	17	1	3	3
VSY	Skagen Plantage	44	698	732	1474			2 3 4	11	9	1	11	2	4	38	76	53	24			3	3
VSY	Bunken Plantage	47	484	690	1221		6	1 2 4	13	12	1	9		4	50	89	61	23		3	2	2
VSY	Råbjerg Plantage	0	64	345	409			1 2	5	5		3			27	40	32	9			2	2
VSY	Ålbæk Plantage	79	525	132	736		1	1 2	6	8		7			23	44	36	13		0	1	1
VSY	Tversted Plantage	94	592	127	812			1 2	4	5		2	1	2	22	36	27	8			1	1
VSY	Uggerby Plantage	83	427	276	786			1 2	1	6		3			25	35	25	6			2	2
VSY	Lilleheden Plantage	56	233	99	388			1 2	2	5		4			14	25	19	8			2	2
VSY	Tornby Plantage	42	280	237	560		14	2 3	2	7		3			27	39	30	5		6	2	2
VSY	Rubjerg Plantage	1	29	28	59			2 3 4	6	1		5	2	4	4	22	14	10			2	2
VSY	Slotved Skov	18	19	104	141	22	9	1 3		2					4	6	3		33	50	1	1
VSY	Blokhus Plantage	52	414	701	1167			1 2	4	5		2		1	13	25	15	6			2	2
VSY	Tranum Plantage	272	1408	2243	3922		4	1 3 4	2	10		5	1	1	31	50	30	10		4	3	4
VSY	Hune Plantage	5	54	6	65			1 2	5	2		3			4	14	10	7			2	2
THY	Lodbjerg Plantage	75	340	616	1031			1 2	1	9		4	1	3	28	46	34	10			2	2
THY	Lyngby Hede		73	1196	1270		5	1 2		6		2			9	17	12	4			2	2
THY	Stenbjerg Plantage, v	12	385	544	941			1 3 4		5		2		1	8	16	8	2			1	1
THY	Stenbjerg Plantage, ø	88	526	317	931		9	1 3 4	1	5		6		2	11	25	20	10		4	1	3
THY	Tvorup Syd	101	933	982	2016		14	1 3	2	10		4		1	24	41	28	7			1	1
THY	Nystrup Plantage, øst	94	833	311	1239			1 2	7	7		7	1	3	10	35	21	12			1	2
THY	Nystrup Plantage, ves	17	234	612	863			1 2	7	7		6		2	11	33	23	14			1	1
THY	Vandet Plantage	88	326	30	444			1 4	4	4	1	2			4	15	8	6			1	1
THY	Vilsbøl Plantage	143	473	603	1218			3 4	2	13	2	6	1	7	20	51	33	16			3	3
THY	Tved Plantage	181	829	434	1444		0	2 3 4	11	9		10		5	29	64	45	20			2	2
THY	Hanstholm Vildtreser		80	3208	3288		2	1 2 3	1	10		4		4	42	61	42	10		1	1	2
THY	Hanstholm Kystskrær	2	5	245	252			3 4		8	2				18	28	21	6			4	3
THY	Østerild Plantage	222	923	450	1595			1 3 4	3	7	1	8	1	10	19	49	25	12			1	3
THY	Madsbøl Plantage	12	325	436	773			3 4	1	4		2		1	14	22	15	3			3	3
THY	Lild Plantage, vestlige	71	631	584	1287		4	1 2	1	3		2	1	3	11	21	12	4		1	1	2
THY	Lild Plantage, østlige	65	367	651	1083			1 2	2	6		3	1	7	38	57	34	8			2	2
THY	Vester Thorup Planta	117	1059	328	1504		7	1 2 3	7	9		4	1	2	23	46	30	13		0	1	2
THY	Fosdal Plantage	147	232	140	520		6	3 4	4	8	2	6		9	22	51	32	14		42	3	3
THY	Slettestrand			549	549			1 3		3					9	12	7	2			1	1
THY	Langdal Plantage	32	122	22	176			3 4	1	1	1	1		3		7	2	2			3	3
KJY	Indskovene	276	88	461	825	13	9	2 4	2	10	2	2		9	11	36	21	13	31	20	2	2
KJY	Hjermind Skov	68	113	84	265	12	3	1 2 3 4	1	3	1	2		3	4	14	6	2	2	24	1	3
KJY	Lysnet			9	9			1 3		1					2	3	3	1			3	3

Forests with zone variability (N = 220) **S6 Table**

Dist	Forest name	Area (ha) Decid	Conif	Jnwood	Total	% already in z3	% already in z4	MX zones chosen	Number of species from each zone group z2	z3	z4	z23	z24	z34	non-forest	Total	Priority A species All	Forest	% of obs already in z3	in z4	MX zone result O3	Q5
KJY	Helgenæs Syd	6	29	174	209			3 4		8	2			3	14	27	21	7			3	3
KJY	Dragsmur	1	2	51	53			1 3		6					20	26	22	4			1	3
KJY	Ørnbjerg Mølle	9	35	53	97	37	2	1 4		3	1	1			5	10	8	3	10		4	4
KJY	Gjerrild Strand	8	2	38	48			1 2	1	2		2		2	5	12	8	4			2	2
KJY	Viborg Plantage	132	275	29	437		3	1 2 3		3		1		2	4	10	9	5			1	2
KJY	Hald Hovedgård	221	81	201	502	6	34	3 4		8	3	2		16	9	38	24	16	12	78	3	3
KJY	Stanghede	37	15	198	249	8	6	3 4		6		6	1	10	13	36	21	10	19	11	3	3
KJY	Hald Sø			342	342			1 3 4		1				2	3	6	2				1	1
KJY	Inderø Skov	70	3	5	78	82	63	3 4		3		3		13	2	21	11	10	46	54	3	3
KJY	Ringelmose Skov	119	42	32	193		2	3 4		5	1	1		12	13	32	25	13			3	3
KJY	Markerne	2	0	388	390			2 3 4	1	4				2	5	12	12	7			3	3
MJY	Sønderskoven	95	640	185	920			1 2	2	4		3		1	6	16	8	2			1	1
MJY	Rydhave Skov	29	1	1	31	61	30	1 3		3				2	1	6	4	3	78		3	3
MJY	Mønsted Kalkgruber	2		15	17			3 4		6	2			1	4	13	6	2			3	4
MJY	Alheden Skov	251	511	81	843			1 2	1	4		4		2	7	18	8	3			1	1
MJY	Kompedal Plantage	243	2062	378	2683			1 2 4	5	7	1	8	1	1	14	37	25	13			1	2
MJY	Haunstrup Brunkulsle	37	73	126	236			1 2	1			2			6	9	6				1	1
MJY	Bøllingsø	29	26	575	630			1 2	1	9		2		3	16	31	14	4			1	2
MJY	Hastrup Plantage	87	404	140	631	6	3	1 3	2	8		4	1	4	5	24	9	5		9	1	1
MJY	Kilderne	86	8	362	456	16	4	1 3		9		2		8	28	47	37	11	42	7	1	1
MJY	Palsgård Skov	149	720	235	1104			1 2 3 4	1	4		2		10	23	40	20	6			2	3
MJY	Gludsted	181	2597	689	3467			1 2 3	8	8		10		5	22	53	33	17			1	2
VAD	Hønning Plantage	120	256	148	524	10	3	1 2	3	7		1		5	10	26	14	8	9	1	1	2
VAD	Lovrup Skov	179	150	54	382	32		1 4	1	4	1	2		2	3	13	4	2	35		1	1
VAD	Soldaterskoven	66	31	76	173			1 3		7		2			4	13	7	4			1	3
VAD	Magisterkog			227	227			1 3		6					20	26	11	2			1	1
VAD	Klaskeroj Skov	73	27	18	118	11	2	1 3	1	3		1		2	2	9	5	3	18		1	3
VAD	Barsbøl Skov	51	25	14	90	15	5	1 2	1	2		1		2	2	8	4	2	38		1	1
VAD	Åtte Bjerge	6		25	31	86		1 3		6					2	8	1		21		1	1
VAD	Stursbøl Hegn	145	244	76	465	3		1 2 3	3	7		1		2	6	19	10	5	2		1	3
VAD	Lindet Skov	160	191	46	397	7	5	1 4	2	7	1	3		7	2	22	9	8	12	68	1	1
VAD	Stensbæk Plantage	82	365	320	767			1 2	2	9		5	1	3	27	47	19	7			1	1
VAD	Kirkeby Plantage	6	166	235	406			1 2 3	1	3		1	1	1	17	24	18	4			1	3
VAD	Vråby Plantage	2	120	33	154			1 2 3	1	6			1		9	17	13	4			1	1
VAD	Tingdal Plantage	11	9	9	29			1 3		4					8	12	9	3			1	3
FYN	Kasmose Skov	11		9	20	44	28	3 4		3	2			10	1	16	5	5	19	20	4	4
FYN	Topgården	2		25	27			1 3 4						1	2	3	3	1			1	3
FYN	Frøbjerg Bavnehøj	1		10	11			1 3		1						1	1	1			1	3
FYN	Flyvesandet			40	40			1 3 4	1	2	1			1	7	12	6	2			1	1
FYN	Nordlangeland	308	44	38	391		1	3 4		5	2	1		2	2	12	8	6			3	3
FYN	Ristinge	12	6	54	72	3		1 3		1				2	11	14	11	3			1	3
FYN	Sydlangeland	106	7	333	447	9	0	3 4	2	15	2			12	21	52	35	21	53		4	3
BLH	Nyminde Plantage, nc	24	255	351	630			1 3	1	5		2		3	21	32	21	4			1	1
BLH	Nyminde Plantage, sy	47	541	332	920			1 2	3	4		1		4	20	32	17	5			2	2
BLH	Kærgård Plantage, no	71	398	285	754		22	1 2 4	1	5	1	4		2	22	35	18	7		3	1	4
BLH	Vrøgum Plantage	81	681	133	896			1 2	2	2		1		1	13	19	10	1			1	1
BLH	Vejers Plantage, sydli	19	387	284	691			2 3	2	4		3		2	17	28	19	5			2	2
BLH	Ål Plantage	95	377	127	599			1 3	1	6		2		1	12	22	15	4			1	3
BLH	Oksby Plantage	25	431	292	748			1 2	3	3		4		1	16	27	15	5			1	1
TRE	Gødding Skov	87	181	25	294			1 3 4	1	2		2		2	1	8	2	1			1	1
TRE	Frederikshåb Plantag	80	504	220	804			1 3	3	9		4		1	11	28	14	6			1	3
TRE	Gyttegård Plantage	34	205	252	491			1 3 4	1	9		5	1	6	37	59	36	10			4	4
TRE	Randbøl Hede	0	2	710	712			1 3	1	9		3		2	33	48	27	6			3	3
TRE	Grund Skov	109	25	21	154		6	3 4		6	2	1		4	1	14	10	9		2	3	3
TRE	Stagsrode Skov	176	30	12	218	5	9	3 4	1	10	5	1		40	1	58	24	24	1	34	4	4
TRE	Kærskov	69	14	6	89			1 2	1	2				1	1	5	3	2			2	2
TRE	Skablund Skov	49	15	14	77			1 4			1			1	1	3	1				1	1
TRE	Rold Skov	57	12	4	73			1 3		1		1		2		4					1	1
TRE	Sønder Stenderup Mi	200	15	26	241	4	2	1 4		2	4			3		9	3	3	6	3	1	4
TRE	Tapsøre Statsskov	148	15	69	232			1 3		2				1	2	5	3	2			3	3
TRE	Kongens Kær			36	36			1 3		1				1	3	5	1				1	1
SDJ	Nørreskov	546	68	122	736	1	7	1 3 4		6		2		9	3	20	12	10	3	6	1	1
SDJ	Oleskobbel	53	2	5	59			1 3		2	1			1		4					1	1
SDJ	Lambjerg Indtægt	63	2	31	96	1	1	1 3 4		2				2	6	10	5	2			1	1
SDJ	Midtskov	5	0	0	5		##	1 4								none					4	4
SDJ	Rønhave Skov	5			5		##	1 4								none					4	4
SDJ	Dybbøl	0		198	198	0	4	1 2 4		5	1				2	8	6	4		13	4	4
SDJ	Dyrehaven	83	10	18	111	4	21	1 3 4		4	3	1		6	3	17	7	4		44	1	3
SDJ	Rinkenæs Skov	192	24	59	275	5	1	1 3	1	9	1			5	5	21	12	8	6		1	3
SDJ	Skodsbøl Skov	60	4	24	87		5	1 3		5		1			1	7	4	3			1	1
SDJ	Hønsnap Skov	62	11	10	84			1 3		3		1		5		9	5	5			1	3
SDJ	Frøslev Plantage	160	538	343	1041	3		1 2	2	7		2	1	7	14	33	17	7	1		2	2
SDJ	Frøslev Mose	7	0	327	335	4	1	3 4	1	10	2	2		7	34	56	26	7	3	2	3	3
SDJ	Areal ved Assenholm			18	18	72		1 3 4		4				1	14	19	16	4	97		1	3

Forests with zone variability (N = 220) **S6 Table** Page 3 of 3

		Area (ha)				% already in		MX zones	Number of species from each zone group								Priority A species		% of obs already		MX zone result	
Dist	Forest name	Decid	Conif	Jnwood	Total	z3	z4	chosen	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4	O3	Q5
SDJ	Bolderslev Skov	109	2	46	157		##	1 3 4		5		2		2	2	11	4	4		100	4	4
SDJ	Jørgensgård Skov	145	9	14	168	4	1	3 4		2	1			3	1	7	4	4	43		3	3
SDJ	Lerskov Plantage	38	82	20	140			1 2	1	4			1	2	3	11	5	2			1	1
SDJ	Hytterkobbel	82	42	13	137			1 3 4		3		1		3	1	8	3	3			1	3
SDJ	Pamhule Skov	234	30	90	353	24	5	3 4		7				17	11	35	16	9	41	0	3	3
SDJ	Østerskov	145	25	15	185	0	0	1 3		5				1	3	9	5	4			1	3
SDJ	Slivsø			198	198			1 3		3				1	13	17	7	2			1	1
STS	Bangsebro Skov	68	3	10	81	1		3 4		3	2			1		6	4	4			3	3
STS	Bøtø Nor	9	3	100	111			1 3		8		2		3	15	28	15	5			1	1
STS	Lysbro Mose ved Hejr	5		52	57			1 3 4		3	1				1	5	2	1			1	1
STS	Ulvshale Skov	90	13	308	410	5	23	2 4	2	17	5	6	1	13	36	80	35	20	1	47	2	4
STS	Kongskilde	37	2	285	324			3 4		14	6			7	12	39	15	10			4	4
STS	Hørhaven	0		44	45			1 3		3				1	1	5	1	1			1	1
STS	Dybsø			136	136			1 2	1	2				1	12	16	13	3			1	2
BON	Kilen	6		1	7			1 2	1					1		2					1	1
BON	Blykobbe Plantage	86	86	32	204	6	18	2 4	3	5	1	4		2	4	19	11	8	4	11	2	2
BON	Ejendommen Lassen	1	6	6	12			1 3							1	1	1				1	3
BON	Pedersker Skov	44	6	38	87			1 3		3						3	2	2			1	1
BON	Hammerknuden	23	5	170	197	51		2 3	2	17		6		7	32	64	38	15	75		2	2
BON	Del af Ringebakkerne			22	22			1 2		6		1		1	4	12	9	6			2	2
BON	Tuleborg	7	1	10	18			1 4		1	1				1	3	1	1			1	1
BON	Rø Plantage	213	320	60	593			2 3 4	6	11		1		5	6	29	12	8			3	3
HST	Jægersborg Hegn	426	32	96	554	15	1	3 4	1	17	13	7		22	18	78	43	34	10	15	3	4
HST	Søllerød Kirkeskov	36	3	9	47			3 4		1	1		1	10	1	14	8	7			3	3
HST	Geel Skov	145	39	9	193			2 3 4	1	6	5		2	7	1	22	13	12			4	4
HST	Enrum Skov	18	1	12	30			1 3				1		2	1	4	3	2			1	3
HST	Rygård	11	0	150	162			1 4		4	2			2	3	11	7	4			1	1
HST	Charlottenlund Skov	51		24	75	13		3 4		2	2		1	2	2	9	6	4	6		3	3
HST	Kongelunden	208	49	74	331			3 4	1	16	2	2	1	10	16	48	28	16			3	3
HST	Vestamager	236		1730	1966	7	2	3 4		16	4	3		7	41	71	40	17	16	0	3	3
HST	Folehave	185	18	60	263			1 2 3	1	3	1			2	1	8	4	4			3	3
HST	Rude Skov og Frihede	321	120	130	571	19	8	1 2 4	2	11	4	5	3	18	9	52	22	18	10	12	1	2
HST	Vestvolden	1		289	290			3 4		7	2	1		6	3	19	9	7			3	3
VSJ	Rørvig Sandflugtsplan	34	136	36	206			1 2	4	1			2		6	13	8	4			1	2
VSJ	Korshage	10	7	60	76			1 2 3		3		1	1	1	13	19	15	2			1	2
VSJ	Hov Vig	9	16	241	266			1 4		12	1	1		6	24	44	25	9			1	1
VSJ	Høve Skov	24	8	8	40			1 2	2	1					1	4	3	2			2	2
VSJ	Kårup Skov	51	93	26	170			1 2	2	4			1	1	14	22	18	5			1	2
VSJ	Sanddobberne	12	0	61	73		18	1 3 4		2				1	7	10	8	3			3	3
VSJ	Røsnæs	22	8	166	196			2 3 4	1	14	4	2	2	11	30	64	37	14			2	2
VSJ	Diesbjerg			3	3			1 3		2					20	22	22	2			1	3
VSJ	Bidstrup Skovene	646	195	181	1021	2	2	3 4	1	15	6	6	4	25	20	77	33	28	5	4	4	3
VSJ	Myrdeskov	47	6	2	55			3 4		2	1			3		6	3	3			3	3
VSJ	Boserup Skov	168	26	29	224	13	6	3 4		10	11		1	20	2	44	20	19	29	3	3	4
VSJ	Hyrdehøjskoven	30	5	18	53			1 4		5	2			1		8	4	4			1	1
NSJ	Sonnerup Skov	45	12	3	60			1 3		4				1	3	8	6	3			3	3
NSJ	Arresø	19		4102	4121			1 4		9	1	1		5	9	25	12	8			1	1
NSJ	Tisvilde hegn	338	1280	375	1992	0	6	2 3 4	25	30	12	16	6	37	66	192	113	63		1	2	2
NSJ	AP-Møllergrunden	2	1	7	9			1 3 4						1	9	10	7				1	1
NSJ	Aggebo og Græsted H	144	24	20	188			1 4		2	1	1	3	6	1	14	9	9			1	1
NSJ	Freerslev hegn	210	30	35	275	9	4	1 3 4		6	1			3	1	11	7	6	9		1	1
NSJ	Stenholt Vang	198	81	35	313		8	1 2 3	2	3		3	1	6	3	18	6	4		5	1	2
NSJ	Esrum Sø			1734	1734			1 3		5				4	9	18	7	4			1	3
NSJ	Nakkehoved	5		23	28			1 3		2				2	5	9	7	3			3	3
NSJ	Hornbæk Plantage	105	71	22	198			2 3 4	3	1	1	4	2	6	4	21	10	7			2	3
NSJ	Teglstrup Hegn	306	138	100	544	26	18	3 4		8	3	4	1	18	22	56	22	14	57	4	3	4
NSJ	Klosterris Hegn	204	122	27	353			1 2 3	1	2	1	3		5	3	15	2	2			1	1
NSJ	Nyrup Hegn	109	103	30	242	1	6	3 4	2	6	1	1	1	5	1	17	7	7		3	3	3
NSJ	Danstrup Hegn	197	78	50	325	0	1	1 2	1	8		1	1	8	6	25	10	6			1	1
NSJ	Krogerup Skovene	64	6	154	223	2		1 3		1	1	1		2	2	7	5	3			1	1
NSJ	Lave Skov og Stejlepl	63	1	5	68	7		1 3		1				1		2	1	1			1	1
OSJ	Ryget	115	21	14	149	17	30	3 4		4	3	3	1	13	16	40	17	12	3	82	4	4
OSJ	Nørreskoven	169	11	13	194	12	9	1 3 4		4	13	1		20	1	39	10	9	12	34	4	4
OSJ	Furesø			932	932			1 3 4		4	1			9	6	20	9	5			1	3
OSJ	Terkelskov	38	3	14	54	45	44	3 4		10	2			8	5	25	14	9	19	21	3	3
OSJ	Ganløse Ore	216	150	30	396		1	2 4	2	7	2		1	10	3	25	16	13			2	4
OSJ	Bøndernes Hegn	55	6	25	85			1 3 4		9	2	1		4	3	19	8	6			1	3
OSJ	Lille Hareskov	110	28	21	159	7	0	1 4		6	2			7	2	17	7	6			1	1
OSJ	Jonstrup Vang	174	27	38	240	11	5	3 4		13	5	1		9	8	36	20	13	6	1	4	4
OSJ	Vestskoven	556	183	604	1342			2 4	1	9	4	2	3	8	17	44	28	17			2	4
OSJ	Ravnsholt	150	123	40	312	1	0	3 4		10	1	1	1	7	3	23	14	12	15		4	4
OSJ	Slagslunde skov	188	17	19	224	1	3	1 3 4		2	4			3	6	15	11	5		3	1	4
	total	19391	42863	52346	114599																	

Forests always in zone 1 (N = 681) **S7 Table**

		Area (ha)				% already		Number of species from each zone group								Priority A species		% of obs already	
Dist	Forest name	Decid	Conif	Unwood	Total	in z3	in z4	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
HIM	Svalebakken			2	2									1	1				
HIM	Stenholmen			1	1										none				
HIM	Julstrup Sø	7	3	82	92				2		1			4	7	3	1		
HIM	Øer ved Hals			8	8										none				
HIM	Lille Ravnkilde			1	1										none				
HIM	Rebstrup			1	1										none				
HIM	Vrå Mølle	0	1	7	8										none				
HIM	Blåkilde Dambrug			5	5										none				
HIM	Dokkedal	2		2	3				2					4	6	5	1		
HIM	Mosskov	133	320	173	625	16	5		5		1		9	8	23	16	9	50	4
HIM	Halkær Mølle			52	52				1					8	9	6	1		
HIM	Naturstien Nibe-Hau			45	45				1					1	2	1			
HIM	Vokslev Kalkgrav	2	0	4	6		31								none				
HIM	Aars Skov	104	68	49	221				1						1	1	1		
HIM	Drastrup Skov	209	42	121	372				1					6	7	6	1		
HIM	Nørager	42	17	18	77								1	1	2	1			
HIM	Poulstrup Skov og K	8	1	38	47				4					2	6	5	3		
HIM	Sct Nicolai Bjerg ved			5	5								1	6	7	5			
HIM	Arden Skov	2		22	24										none				
HIM	Østre Banevej Skov	41	120	72	233	3	4		2		1		6	4	13	9	5	2	37
HIM	Hyllebjerg	0		6	6										none				
HIM	Grønnerup Strand	0	0	5	5										none				
HIM	P-plads ved Svingelb			1	1										none				
HIM	Lille Skovsgårds Hag			2	2										none				
HIM	Lundshøj	4		7	11		39						1	3	4	4	1		25
HIM	Als Havbakker			12	12									2	2	2			
HIM	P-plads ved Als Odd				0										none				
HIM	Muddermarens Ø			1	1										none				
HIM	Pletten			16	16									1	1	1			
HIM	Jenle Plantage	14	68	10	92			1			1			1	3	1	1		
HIM	Plovmandshøj Plant	20	68	3	90				1						1				
HIM	Frendrup hede - Vol	2		11	13									1	1				
VJY	Rønland Sandø			3	3										none				
VJY	Gørding Havn			1	1										none				
VJY	Skærum Mølle	19	4	67	90									2	2	1			
VJY	Langerhuse			0	0										none				
VJY	Sønderholmene og I			140	140				1					2	3	3	1		
VJY	Høfde 8			4	4										none				
VJY	Arealer ved Fjaltring			92	92									2	2	1			
VJY	Bøvling Klit			44	44									1	1	1			
VJY	Rammedige			16	16										none				
VJY	Femhøjsande	8	28	2	38										none				
VJY	Øster Lem Hede			86	86									1	1				
VJY	Nørre Vium Brunkul	27	10	11	48						3			1	4	1			
VJY	Troldhede Brunkulsl	15	19	24	58				1		2			2	5	2			
VJY	Ahlergaarde Brunku			6	6										none				
VJY	Lystbæk	26	71	239	336				1		1			9	11	8	1		
VJY	Rejkær Hede			45	45				2					1	3	2	1		
VJY	Arealer i Holmsland			297	297				3					6	9	6	2		
VJY	Feldsted Kog			1483	1483									14	14	9			
VJY	Skårmose Plantage	30	60	29	119									1	1	1			
VJY	Ølgryde Plantage	75	273	64	413		7				2		1	1	4				
VJY	Døes Højene			16	16										none				
VJY	Møborg Skov	45	60	49	154						2			1	3	1			
VJY	Storåen,Naur			7	7										none				
VJY	Naturskolen Kærgår			3	3				1						1	1	1		
VJY	Resenborg Plantage	19	4	2	26				2					1	3	2	1		
VJY	Birkild Hede			7	7									1	1				
VJY	Livbjerggård Strand			6	6										none				
VJY	Grisetå Odde			7	7									1	1	1			
VJY	Plethøj	10	0	5	15										none				
VJY	Bøløre Odde			2	2										none				
VJY	Søndbjerg Strand	2	1	2	5									2	2	2			

Forests always in zone 1 (N = 681) **S7 Table**

																Priority A		% of obs	
		Area (ha)				% already		Number of species from each zone group								species		already	
Dist	Forest name	Decid	Conif	Unwood	Total	in z3	in z4	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
VJY	Odby			2	2										none				
VJY	Skalstrup Skov	40	95	6	141										none				
VJY	Åbjerg Skov	31	66	55	152				1					1	2	2	1		
VJY	Harpøth Bæk og Dal			4	4										none				
VJY	Nees Sandø			3	3										none				
VJY	Toftum Bjerge og Je	2	0	21	23									2	2	2			
VJY	Gejlgård Bakke			0	0										none				
SHL	Arealer ved Skæring	1		9	9									3	3	1			
SHL	Ajstrup Strand Og N		0	19	19				2					1	3	3	2		
SHL	Areal ved Brabrand			0	0										none				
SHL	Stendysse ved Orms				0										none				
SHL	Kollens Mølle	2		1	3										none				
SHL	Bærmose- Himmerig	132	25	58	215				1					3	4	2	1		
SHL	True Skov	260	36	147	443				1					1	2	2	1		
SHL	Hvinningdal Skov	49	45	53	147									1	1	1			
SHL	Solbjerg Skov	94	4	32	129									1	1	1			
SHL	Anebjerg Skov	71	4	36	111				4					1	5	3	2		
SHL	Geding Skov	18	3	7	28				1						1	1	1		
SHL	Rugballegård Skov	61	12	33	106										none				
SHL	Arealer i og ved Bryr			12	12										none				
SHL	Illerup Ådal			32	32				1					1	2	1			
SHL	Opholds- og stiareal	0		7	7				1						1				
SHL	Areal ved Solbjerg S			8	8										none				
SHL	Ring Kloster			1	1				1				1		2	1	1		
SHL	Fårbjerg			4	4				2					5	7	6	1		
SHL	Naturstien Horsens-			84	84										none				
SHL	Slaggård Banke			2	2									2	2	2			
SHL	Tunø og småøer	1	1	33	35									1	1				
SHL	Arealer på Samsø	6	3	321	329				4					20	24	20	2		
SHL	Meden Kirkeruin				0										none				
SHL	Kysing Strand			6	6								1		1				
SHL	Hølken Strand			10	10										none				
SHL	Spøtterup Strand			2	2										none				
SHL	Hou Strand			1	1										none				
SHL	Hundslund-Åkjær na			10	10				1						1	1	1		
SHL	Mosevej			0	0										none				
SHL	Lovdal Skov	7	24	3	33		4								none				
SHL	Østre Stenhule	24	28	16	68	4	27								none				
SHL	Alling, vestlige del	4		4	8										none				
SHL	P-plads syd for Alling			0	0										none				
SHL	Arealer ved Masken	0	0		1										none				
SHL	Areal ved Knudsø sy	1		3	4										none				
SHL	Knudhule Strand	1		18	19										none				
SHL	Vestbirksøerne	1	0	58	59				3					2	5	4	2		
SHL	Mossø Brå	1		31	32									2	2	1			
SHL	Bryggebjerg				0										none				
SHL	Birkhede	1		6	8									1	1				
SHL	Øm Kloster			0	0										none				
SHL	Pindals Mose	1		0	1				2						2	2	2		
SHL	Vilholt			1	1										none				
SHL	Siim Skov	26	10	11	47				2						2	1	1		
SHL	Østerskoven, vestlig	9	7	2	18	55					1				1	1	1	33	
SHL	Sminge kanolejrplac			1	1										none				
SHL	Anderiet mm.	1		4	5									1	1	1			
SHL	Bøsmølle Bro			0	0										none				
SHL	P-plads ved Nebel B			0	0										none				
SHL	Trækstien			16	16									1	1	1			
SHL	Sorring				0										none				
VSY	Nordmarken			57	57			3	2					3	8	6	3		
VSY	Danzigmand og Bløc	3	1	98	102				2					2	4	3	1		
VSY	Vesterø Sønderland	0	3	347	349				3		1			14	18	13	2		
VSY	Rønnerne	14	8	677	700				2					10	12	10	1		
VSY	Borfeld			0	0									2	2	1			

Forests always in zone 1 (N = 681) **S7 Table**

		Area (ha)				% already		Number of species from each zone group								Priority A species		% of obs already	
Dist	Forest name	Decid	Conif	Unwood	Total	in z3	in z4	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
VSY	Hvide Fyr			0	0										none				
VSY	Byfogedskoven	6	2	2	10								1		1				
VSY	Skiverbakken			77	77				3					18	21	17	1		
VSY	Skiveren Plantage	1	10	14	25				2		1				3				
VSY	Tversted Rimmer	8	47	106	161				4					9	13	11	2		
VSY	Råbjerg Mose			196	196			1	4					11	16	11	2		
VSY	Videslet Engen			13	13				1					6	7	5			
VSY	Hirsholmene			48	48									8	8	4			
VSY	Areal ved Hulsig		2	12	14										none				
VSY	Tversted Klit	1		36	37									3	3	3			
VSY	Nejst Plantage	10	30	1	41										none				
VSY	Kærsgård Strand			45	45				1					16	17	15	1		
VSY	Lien Skallerup			6	6										none				
VSY	P-plads ved Skalleru			0	0										none				
VSY	Areal ved Lønstrup			1	1										none				
VSY	Mårup Kirke			0	0										none				
VSY	Rubjerg Knude Fyr			3	3										none				
VSY	Kajholm	20	11	15	46										none				
VSY	P-plads ved Kodal			0	0										none				
VSY	Hjørring-Astrup sko	12	3	61	77										none				
VSY	Måstrup Mose			1	1										none				
VSY	Mosbjerg	5	2	48	55				10		1		2	8	21	11	4		
VSY	P-plads ved Åsted Å				0										none				
VSY	Areal ved Sulbæk			4	4										none				
VSY	Solsbæk Strand		2	36	38				1					3	4	2			
VSY	Søheden Skov	14	2	16	31		17								none				
VSY	Slettingen	4	0	36	40		45							2	2	1			
VSY	Nybæk Plantage	16	51	49	116				1					3	4	3			
VSY	Munkens Klit			32	32				2					1	3	3	2		
VSY	Lille Norge	4	2	31	36				3					6	9	7	2		
VSY	Fårup Klit	18	24	12	53										none				
VSY	Pirups Hvarre		4	29	33										none				
VSY	Grishøjgårds Krat	4		161	165				5		3			10	18	10	4		
VSY	Gjøl Bjerg			3	3										none				
VSY	Store Vildmose			869	869				3		1		2	5	11	2	1		
THY	Agger Tange			765	765				5		3			17	25	17	5		
THY	Egebjerg			8	8									1	1				
THY	Aaby Skoven	28	4	33	65				1						1	1	1		
THY	Rønhede Plantage	44	51	7	102				1						1	1	1		
THY	Fjordholmene			4	4										none				
THY	Ydby-Nygård Planta	2	0	8	10				1					1	2	1	1		
THY	Hurup Golfskov	13	1	0	14										none				
THY	Faddersbøl	12	13	13	38										none				
THY	Sundby Sø			83	83									1	1	1			
THY	Øer omkring Mors			7	7										none				
THY	Ejerslev Vang			12	12				1					2	3	3	1		
THY	Areal ved Hanklit			4	4										none				
THY	Buksør Odde			39	39				2					2	4	3	2		
THY	Legind Vejle	1		77	78				1					3	4	4	1		
THY	Tissing Vig			93	93									5	5	2			
THY	Arealer Ved Søndre			132	132								1	1	2	1			
THY	Tvorup Nord	29	455	67	552			1	1		3		1	9	15	7	1		
THY	Vangså Hede		5	618	623				5		1			16	22	13	2		
THY	Snedsted Byskov	3	0		3										none				
THY	Kronens Hede Plant	5	172	19	196		9		2					6	8	6	1		
THY	Bavn Plantage	18	11	9	38									2	2	2			
THY	Sjørring Volde	2		1	3										none				
THY	Arealer ved Langdys			1	1										none				
THY	Eshøj	6	1	2	8										none				
THY	Hanstholm Byplanta	27	48	46	121									6	6	5			
THY	Vigsø rallejer			340	340			1	5					9	15	9	3		
THY	Vigsø og Ballerum P	47	160	80	286			1	1					5	7	6	1		
THY	Korsø Plantage	55	356	434	845			1	1					7	9	5			

Forests always in zone 1 (N = 681) **S7 Table**

		Area (ha)				% already		Number of species from each zone group								Priority A species		% of obs already	
Dist	Forest name	Decid	Conif	Unwood	Total	in z3	in z4	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
THY	Hjardemål Plantage	61	707	388	1156		11	2	6		3			21	32	19	4		35
THY	Tømmerby Kær	4	134	115	254				1					2	3	2			
THY	Areal ved Selbjerg V			1	1										none				
THY	Frøstrup Skov			9	9										none				
THY	Aggersborg			10	10										none				
THY	Kollerup Plantage	41	254	185	479			2	3		6			7	18	11	5		
THY	Hingelbjerg	0	0	3	3										none				
THY	Hingelbjerg Mose			0	0										none				
THY	Husby Hole			0	0										none				
THY	Bredkær Plantage	9	27	1	37										none				
KJY	Udskovene	201	136	14	350	20	4		2				2		4	3	3		
KJY	Randers Nørreskov	10			10										none				
KJY	Randers Nordre Fæl	44	3	93	140										none				
KJY	Vindum Skov	161	116	47	324	27	2		2		1		2	3	8	4	2	33	
KJY	Busbjerg	2			2										none				
KJY	Frisenvold Laksegår	1		135	135		3							4	4	3			
KJY	Frydensbjerg og Kat	4		10	15				2				1	9	12	9	1		
KJY	Hohøj Arealer			2	2										none				
KJY	Hadsund Bane			9	9										none				
KJY	Mosely	11		21	32				3					2	5	4	2		
KJY	Hærup P-plads			0	0										none				
KJY	Ulbjerg Klint			24	24									2	2	2			
KJY	Sundstrup Arealerne			20	20									1	1	1			
KJY	Rønnen			0	0										none				
KJY	Bjødstrup Strand			3	3										none				
KJY	Karpenhøj	1	0	48	49				1					4	5	5	1		
KJY	Vænge Sø			49	49				2					5	7	4			
KJY	Mågeøen			10	10										none				
KJY	Areal ved Stubbe Br	3		4	7								1		1				
KJY	Natursti Ebeltoft-Gr			14	14								1		1				
KJY	Vibæk Strand			0	0										none				
KJY	Holme strandareale			10	10									3	3	3			
KJY	Hyllested Bjerge	3	9	27	39	98					1				1			100	
KJY	Bisballe-Almind	12	15	105	132	20	1		1				1	7	9	7	1	11	
KJY	Bruunshåb	1		3	3										none				
KJY	Klostermarken	27	2	46	75				1					8	9	8			
KJY	Klokkerholm Skov	24	4	5	32									1	1				
KJY	Randers Sønderskov	24	5	10	39				1						1	1	1		
KJY	Øer i Randers Fjord			3	3										none				
KJY	Elløv Enge	2		26	27										none				
MJY	Borbjerg-Nørreskov	453	1662	262	2376			3	7		4		1	2	17	10	9		
MJY	Sjørup Skov	82	208	42	331									1	1	1			
MJY	Arealer på Nordfur	5	7	87	98				2					3	5	4	1		
MJY	Jenle	7	1	31	38	6	13								none				
MJY	Brokholm Sø	1		141	143				3					2	5	3	2		
MJY	Havbjerg Skov	42	43	62	146				1					3	4	3	1		
MJY	Vinderup Skov	58	24	89	171									1	1	1			
MJY	Geddal Strandenge			126	126				1					10	11	5	1		
MJY	Spøttrup Sø	1	1	113	114				1					1	2	2	1		
MJY	Arealer på Lundø			12	12										none				
MJY	Egekrat ved Aulum	3			3		100								none				
MJY	Småarealer Salling	3		24	27										none				
MJY	Grynderup Sø		1	78	79				1					1	2	1			
MJY	Arealer ved Durup			1	1										none				
MJY	Løvbakke Skov	101	39	46	186				2					1	3	3	2		
MJY	Areal ved Rabis			63	63									2	2	1			
MJY	Ikast Byskov	60	15	20	94				1					1	2	2	1		
MJY	Søby Brunkulslejer	23	129	215	366			1	4		5			6	16	8	3		
MJY	Funder-Ejstrup natu	13	5	55	72									4	4	2			
VAD	Råbjerg Plantage	40	61	15	117	21	15		1						1	1	1		
VAD	Renbæk Plantage	67	94	44	205			1	4				1	3	9	3	1		
VAD	Arrild Plantage	13	50	7	69				1						1				
VAD	Nørreskov	12	1	16	29									1	1	1			

Forests always in zone 1 (N = 681) **S7 Table**

Dist	Forest name	Area (ha) Decid	Conif	Unwood	Total	% already in z3	in z4	Number of species from each zone group z2	z3	z4	z23	z24	z34	non-forest	Total	Priority A species All	Forest	% of obs already in z3	in z4
VAD	Gasse Høje			2	2										none				
VAD	Nørresø og Hestholı			94	94				2					13	15	8	2		
VAD	Haraldsholm Skov	72	52	5	129			1					1		2				
VAD	Jelssøerne			89	89				3		1		1	3	8	5	3		
VAD	Sidekanal ved Lintru			1	1										none				
VAD	Parceller i Sømose c			2	2									1	1	1			
VAD	Jættestuer ved Over			1	1										none				
VAD	Skrydstrup Skov	12	2		13										none				
VAD	Lindet Mose			31	31		100		1					1	2	1			100
VAD	Mandbjerg Skov	43	1	14	58	58	14								none				
VAD	Varming og Nørbæk	99	296	63	458		3	1	4		1			2	8	2	2		8
VAD	Toftlund Skov	48	2	12	62	16			1					1	2	1		50	
VAD	Dankirke		0	4	4										none				
VAD	Bevtoft Plantage	44	134	14	191			1	4		1			1	7	3	2		
VAD	Gammelskov	4		11	15									1	1	1			
VAD	Bjerreskov	59	18	34	112									1	1	1			
VAD	Favrholt Skov	7	2	1	10										none				
VAD	Tange Bakker	10	10	41	60				1		2			7	10	4	2		
VAD	Tange Enge			3	3										none				
VAD	Tvismark Plantage	2	60	240	302				1		1			10	12	10	2		
VAD	Vestergårde Bjerge			11	11									2	2	2			
VAD	Albatros			1	1										none				
VAD	Klægtagningsarealeı			67	67				1					7	8	5	1		
VAD	Arealer ved Husum			2	2									1	1	1			
VAD	Areal på Mandø			50	50									9	9	5			
FYN	Røjle Klint			2	2										none				
FYN	Fortidsminder			2	2										none				
FYN	Småøer		0	31	31				1					6	7	3	1		
FYN	Vestermose Skov	33	1	12	46									1	1	1			
FYN	Holmeskoven	18	2	4	25										none				
FYN	Klakkebjerg	5	2	27	34				2		1			3	6	4	2		
FYN	Arealer ved Vissenb	1		14	15										none				
FYN	Feddet			72	72				2					6	8	6	1		
FYN	Helnæs Made	2		248	250	1			3				4	11	18	11	3		
FYN	Nørreby Hals			32	32										none				
FYN	Fuglsanggård	22		9	31										none				
FYN	Otterup Byskov	22	1	10	33				1						1	1	1		
FYN	Fjordmarken			63	63				2				1	5	8	5	2		
FYN	Vigelsø	24		108	132				1					4	5	2	1		
FYN	Kirkendrup Skov	64	7	79	150				1					1	2	2	1		
FYN	Elmelund Skov	132	15	124	270				1						1	1	1		
FYN	Fyns Hoved	2		46	48				3				2	9	14	10	3		
FYN	Bogensø Strand			7	7						1			2	3	3	1		
FYN	Lods Huse			2	2										none				
FYN	Lærkedal	22	3	29	54				2				1	1	4	3	2		
FYN	Sønderskovgård	14	29	6	49										none				
FYN	Storelung			2	2									2	2	2			
FYN	Ringe Skov	101	5	63	169				1						1	1	1		
FYN	Naturstien Ringe - K			23	23										none				
FYN	Trente Mølle	9	10	15	33				4		1		1		6	3	3		
FYN	Lyø	6	1	9	16				1					1	2	1	1		
FYN	Avernakø			13	13				1					2	3	2	1		
FYN	Tåsinge Vejle			35	35				2				1	5	8	6	2		
FYN	Vorbjerg	9		2	11										none				
FYN	Borgnæs	17		12	29								1		1				
FYN	Gråsten Nor	5	8	68	81										none				
FYN	Toftegårdsskoven	13		3	16									1	1	1			
FYN	Egehovedskoven	13	8	10	32										none				
FYN	Hov Østerland	0		7	7										none				
FYN	Rudkøbing Fredskov	18		7	24				1						1				
FYN	Humble Byskov	23	3	8	34										none				
FYN	Næs	4			4	100									none				
BLH	Blåbjerg Plantage	124	806	467	1396	1	8	2	6		6		1	21	36	23	6		

Forests always in zone 1 (N = 681) **S7 Table**

		Area (ha)				% already		Number of species from each zone group								Priority A species		% of obs already	
Dist	Forest name	Decid	Conif	Unwood	Total	in z3	in z4	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
BLH	Nørre Nebel Skov	100	17	46	163				2					3	5	5	2		
BLH	Golfbane			37	37										none				
BLH	Oversigtsareal ved H			0	0										none				
BLH	Årgab			2	2										none				
BLH	Bavnebjerg			154	154				1					6	7	5	1		
BLH	Havrendingen			91	91									1	1				
BLH	Bjergeborg			33	33									1	1	1			
BLH	Bjerregård		8	28	36										none				
BLH	Holmsland Klit			154	154									5	5	5			
BLH	Tipperne			689	689				3				1	17	21	11	2		
BLH	Klægbanken mm.			67	67									6	6	3			
BLH	Præstens ø og Tykrå			3	3										none				
BLH	Polde			4	4									2	2				
BLH	Øer i Nymindestrøm			112	112									7	7	4			
BLH	Skjern Å	3	2	1963	1967				4		1		2	29	36	21	2		
BLH	Lønborg Hede			344	344				3				1	14	18	13	1		
BLH	Kærgård Plantage, s	3	192	412	608			1	2		2			17	22	13	3		
BLH	Vejers Plantage, nor	30	358	305	693			1	4		1			13	19	13	3		
BLH	Sig kapelbanke			3	3										none				
BLH	Bordrup Plantage	45	625	185	856			1	3		1			15	20	16	3		
BLH	Ho Plantage	26	302	95	423			2	2		1			12	17	13	2		
BLH	Langli			100	100				2				1	17	20	12	2		
BLH	Fyrpasserboligen			0	0										none				
BLH	Hafniagrunden			11	11				1					1	2				
BLH	Oles Dige			1	1										none				
BLH	Lodder Øst for Oksb			11	11									1	1	1			
BLH	Kikkebjerg Plantage	1	27	8	36				1					1	2	1	1		
BLH	Torp	2	3	3	8										none				
BLH	Sønderho			1	1										none				
BLH	Søren Jessens Sand			93	93										none				
BLH	Trinden og Keldsanc			54	54										none				
TRE	Engelsholm Skov	65	19	64	147	20	0							1	1	1			
TRE	Tykhøj Krat	24	55	7	86	7			1		1				2	1	1		
TRE	Refstrup Skov	26	1	1	27										none				
TRE	Nørup Plantage	9	2	0	11										none				
TRE	Vingsted Mølle	12	0	23	35				1				1	1	3	2	1		
TRE	Randsfjord Arealer	10	0	30	40		3		2		1		4	2	9	5	5		
TRE	Vognkær Enge og H	8	0	27	35									1	1	1			
TRE	Børkop Vandmølle	1		6	8									1	1	1			
TRE	Fårup Skov	7		3	10										none				
TRE	Fire Høje			3	3										none				
TRE	Sophienlund	9		1	10										none				
TRE	Haltrup Hede		13	48	61									3	3	3			
TRE	Troldhedebanen Ve			3	3										none				
TRE	Eg Rasteplads			2	2										none				
TRE	Tirsbjerg Plantage	11	12	1	24						1				1				
TRE	Bjerge Skov	215	43	25	282		4		5		1		3	3	12	6	5		16
TRE	Tønballegård	25	23	23	71	9			3						3	2	2		
TRE	Bankehave	54	9	6	69				2						2	2	2		
TRE	Boller Nederskov	122	19	15	156	8	2		3				2		5	2	2	22	
TRE	Boller Overskov	55	1	2	59				1					1	2				
TRE	Klokkedal	54	5	5	63	14	5		2				1	1	4	2	1	48	
TRE	Ustrup Bjerge	17	9	1	28										none				
TRE	Dybdal	16	6	1	22									1	1	1			
TRE	Dallerup Skov	51	6	7	63				2				1	1	4	3	2		
TRE	Lystrup Skov	27	7	2	36										none				
TRE	Borringholm			2	2										none				
TRE	Sebberup Skov	92	7	42	141				1					1	2	1			
TRE	Sønder Stenderup N	331	51	30	412	6	1		4				2	5	11	6	3	2	
TRE	Stenderup Hage			3	3										none				
TRE	Sønder Stenderup S	144	22	27	193	14	5		6		1		4	2	13	4	4	8	10
TRE	Skibelund			7	7										none				
TRE	Grønninghoved Stra	17	1	0	18	100									none				

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		Area (ha)				% already		Number of species from each zone group								Priority A species		% of obs already	
Dist	Forest name	Decid	Conif	Unwood	Total	in z3	in z4	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
TRE	Vargårde Skov	41	5	5	50	14	1								none				
TRE	Trommersgård Skov	22	2	4	28	9			1						1	1	1		
TRE	Fovslet Skov	199	48	14	260	6	3		6				3	1	10	5	5		3
TRE	Hoppeshuse	59	8	100	167				1						1	1	1		
TRE	Harte Skov	103	58	78	240		2		6					4	10	8	5		
TRE	Troldhedebanen			17	17				2					4	6	4	1		
TRE	Rastepladser ved Ny			4	4									1	1	1			
TRE	Hakonsminde			5	5										none				
TRE	Søballegård	1		19	20		3		1						1	1	1		
TRE	Tørrepladsen	0		0	1									1	1	1			
TRE	Klingebæk	4		14	18									4	4	4			
TRE	Ravning Enge			6	6										none				
TRE	Bindeballe Station			0	0										none				
TRE	Troldhedebanen Syd			8	8										none				
SDJ	Karholm	3		0	3	100									none				
SDJ	Øvelgunde Fredskov	21		1	22										none				
SDJ	Fryndesholm	35		2	36										none				
SDJ	Græskobbel	4			4		100		1						1				100
SDJ	Blommeskobbel	35	1	7	42		4		3				2		5	2	2		
SDJ	Rumohrsgård Dyreh	21	7	4	32				1				1	1	3	2	1		
SDJ	Ketting Nor			65	65				3				1	4	8	5	2		
SDJ	Oldenor	4		44	48				2				1	1	4	2	1		
SDJ	Augustenborg Skov	28	1	2	31	100			2				2		4	1	1	100	
SDJ	Made Skov	17		2	20	22	13		2						2	1	1	75	
SDJ	Arnkil Skov	61	0	44	106		5		8				1		9	5	5		
SDJ	Arnkil Maj	10		2	12										none				
SDJ	Fredskov	8	4	1	13		13		1						1	1	1		
SDJ	Mjang Dam			128	128				2					4	6	4	2		
SDJ	Hartsø Strand			4	4								1	1	2	2	1		
SDJ	Nydam Mose			3	3										none				
SDJ	Roden Skov	115	7	23	145	4	4		1					2	3	3	1	17	17
SDJ	Adsbøl Dam	2		2	4	98								1	1	1		100	
SDJ	Sø- og Lystskovareal	10		64	75	10	10		3				3	5	11	6	3		27
SDJ	Over- og Nederstjer	30	1	4	34	2			1						1				
SDJ	Buskmose Skov	59	2	21	82				1					1	2	2	1		
SDJ	Avnbøl Sned	39	4	1	44										none				
SDJ	Bøffelkobbel	14		1	14										none				
SDJ	Skelde Folekobbel	27	1	2	30		12		1						1	1	1		
SDJ	Skelde Kobbelskov	63	3	7	73		1		4	1			1		6	2	2		
SDJ	Opholdsarealer ved			1	1										none				
SDJ	Helligsø			15	15									1	1	1			
SDJ	Nybøl			7	7										none				
SDJ	Arealer ved Strande	1		0	1										none				
SDJ	Kelstrup Fredsskov	53	8	7	68				1				2		3	2	2		
SDJ	Kelstrup Plantage	147	130	54	331		3	1	5		2		1	1	10	3	2		
SDJ	Rode Skov	16	18	36	70				5		2		1	3	11	6	3		
SDJ	Kiskelund Plantage	29	26	9	64				4		1		1	1	7	4	3		
SDJ	Kollund Skovholm	2			2										none				
SDJ	Kruså Skov	14	1	2	17		97		1					1	2	1			75
SDJ	Mølleskov	3		1	4	15	68							1	1	1		100	
SDJ	Store Okseø			8	8										none				
SDJ	Gårdbæk Skov	16	2	2	20				2						2	1	1		
SDJ	Waldeck Skov	3	1	1	5										none				
SDJ	Rønshovedskovene	14		0	14				2						2	1	1		
SDJ	Gammelmose Skov	11	3	18	32										none				
SDJ	Lyreskoven	23	2	6	31										none				
SDJ	Parcel i Søndermose			4	4										none				
SDJ	Kragelund Mose			10	10				2					2	4	2	1		
SDJ	Vejbæk Skov	36	39	12	87										none				
SDJ	Bommerlund Planta	155	368	151	674		0	2	5		1		1	2	11	4	3		
SDJ	Oksekær	1		2	3										none				
SDJ	Skov ved Bjerndrup	1			1									1	1	1			
SDJ	Bøghoved	13	4	2	20		25		1				1		2	1	1		

Forests always in zone 1 (N = 681) **S7 Table**

		Area (ha)				% already		Number of species from each zone group								Priority A species		% of obs already	
Dist	Forest name	Decid	Conif	Unwood	Total	in z3	in z4	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
SDJ	Areal syd for Sønder			3	3									1	1	1			
SDJ	Hostrup Krat	16	12	4	31	3	3		3				1	1	5	2	2		5
SDJ	Kæmpehøj i Hostrup				0										none				
SDJ	Arealer på Varnæs H	1		79	80				1					1	2	2	1		
SDJ	Årtoft Plantage	72	134	43	250				4		1		1	2	8	4	2		
SDJ	Torp Plantage	87	84	38	209									1	1	1			
SDJ	Hjordkær	5	1	1	7										none				
SDJ	Årup Skov	195	36	55	285	1	0		3				1	1	5	3	2		
SDJ	Sønderskov, Aabenr	86	7	11	104				1				1	1	3	2	1		
SDJ	Hjælm	44	2	5	50	14			4				1	1	6	2	2		
SDJ	Vestermark	96	10	14	120	2	3		1					1	2	2	1	13	
SDJ	Langbjerg Skov	36	0	13	50		3		2						2	1	1		
SDJ	Søst Skov	56	8	12	77		10		4						4	3	3		13
SDJ	Nørreskov, Aabenra	76	9	13	97				2					1	3	3	2		
SDJ	Rhedersborg Skov	25	9	4	37									1	1	1			
SDJ	Rugbjerg Plantage	33	112	19	164								1	1	2				
SDJ	Rundemølle	1		5	5	38	13								none				
SDJ	Jagtprøvebane		1	8	9										none				
SDJ	Strangelshøj			1	1										none				
SDJ	Hjarup Mose			7	7									1	1	1			
SDJ	Arealer ved Potterh			19	19									1	1	1			
SDJ	Hop Sø			11	11				1				1	1	3	2	1		
SDJ	Tormaj	7		4	11										none				
SDJ	Fredshule	2		9	11										none				
SDJ	Abkær Mose			37	37									1	1	1			
SDJ	Femhøje			3	3										none				
SDJ	Haderslev Sondersk	70	6	71	147	34			1				2		3	2	2		
SDJ	Hjelmvrå	44	6	2	51				2				1		3	1	1		
SDJ	Teglholt	20	2	17	40	12	3		1				1	2	4	2	1	46	
SDJ	Tørning Mølle	21	1	68	90	8	1		2				2	2	6	3	2	17	
SDJ	Sandkule	43	2	2	47	58	40		1				1	1	3	1	1	93	
SDJ	Ladegård eng	0		10	11				1					1	2	1			
SDJ	Elkær dambrug			5	5									1	1	1			
SDJ	Vesterskov	151	17	20	187	12	2		6				1	3	10	5	3		
SDJ	Nautrupgård Skov	9		0	9										none				
SDJ	Tamdrup Høj			0	0										none				
SDJ	Årø Skov mm	7		48	54				5					6	11	8	4		
SDJ	Keldet Skov	9			9										none				
SDJ	Loft Skov	15	2	1	18									1	1				
SDJ	Revsø Skov	137	42	34	213	3	1		4				1	3	8	4	3	3	3
SDJ	Gravhøj i Sommerst			0	0										none				
SDJ	Areal ved Råde Strai			3	3										none				
STS	Ovstrup Skov	159	22	40	221										none				
STS	Sønder Kohave	60	1	8	70		14								none				
STS	Gedser Fyr			4	4				3					5	8	6	3		
STS	P-pladser på Falster			5	5										none				
STS	Albuen			43	43				2					8	10	6	2		
STS	Langødyssen og Bav			1	1										none				
STS	Majbøllereservatet			34	34				1					8	9	4	1		
STS	Enehøje	1	2	97	100								1	5	6	5			
STS	Teglværksskoven	8		16	24				1				1	3	5	1			
STS	Vildmarksskoven	7		2	9										none				
STS	Krogsbølleskoven	15	0	5	20										none				
STS	Krukholm Skov	24		14	37										none				
STS	Hyllekrog Fyr			2	2									1	1	1			
STS	Krukholm Lille Skov	4		2	6										none				
STS	Øer på søterritoriet			15	15									1	1	1			
STS	Mark ved Bursø			9	9										none				
STS	Udby Skov	59	8	38	105				1						1				
STS	Hegnede Skov	16	1	13	30				1					2	3	3	1		
STS	Nyord			136	136				2					9	11	7	2		
STS	Areal ved Hjelm Bug	1		1	2										none				
STS	Bakkely Skov	37	8	18	63										none				

Forests always in zone 1 (N = 681) **S7 Table**

			Area (ha)			% already		Number of species from each zone group								Priority A species		% of obs already	
Dist	Forest name	Decid	Conif	Unwood	Total	in z3	in z4	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
STS	Tårnborggård			63	63				1					4	5	3	1		
STS	Galgebakke og Hash			0	0										none				
STS	Højbjerg Skov	35		76	112				1						1	1	1		
STS	Kobæk Skov	30	1	68	99				1				1	6	8	6	2		
STS	Glumsø Statsskov	8		36	44				1				1	3	5	2	1		
STS	Areal ved Sandvig			9	9										none				
STS	Prins Carls Skole				0										none				
STS	Gåsetårnet				0										none				
STS	Faksinge Skov	18		2	20										none				
STS	Vrangstrup Enge v. S			51	51				2					2	4	2	2		
STS	Anneliselunden			6	6										none				
STS	Stevns Fyr			0	0										none				
STS	Avnø	3		207	211				11				1	20	32	16	5		
STS	Rønnebæk fælled	30	7	58	95				1				1		2	1	1		
STS	Ladby Skov	17		18	35										none				
STS	Fælleseje Skov	23	1	12	35										none				
STS	Vridsløse Skov	20		35	55										none				
STS	Even Skov	25	2	20	46										none				
STS	Fakse Kalkbrud			15	15										none				
STS	Fodsporet	20	0	63	83				1				1	1	3	2	1		
STS	Øer på søterritoriet			9	9									2	2	2			
BON	Arealer ved Arnager	4	1	3	8				2					1	3	3	2		
BON	Areal ved Sose Odde			0	0										none				
BON	Areal ved Nordbakk		2	1	2										none				
BON	Areal ved Gubbegår		1	2	3										none				
BON	Egeby fortidsminde			1	1										none				
BON	Areal ved Hundsem			0	0										none				
BON	Udkæret	3	0	24	27				6					5	11	5	3		
BON	Kærgården	1	1	25	27				3					4	7	5	2		
BON	Skovholt	1		4	5									2	2	1			
BON	Ringborgen	0		10	10										none				
BON	Arealer ved Vandmø	1		1	2										none				
BON	Areal ved Stammers	1		1	2				1						1	1	1		
BON	Byggehøj	2			2		100								none				
BON	Rø Præsteskov	4			4										none				
BON	Øster Borregårds Sk	24	7	10	40	4	27		2						2	1	1	83	
BON	Areal ved Bobbeå	4	1	2	7		67								none				
BON	Salene Bugt	5	1	3	8										none				
HST	Trørød Hegn	51	1	4	55										none				
HST	Kohave Skov	21	0	13	34						1		1	1	3	1			
HST	Ermelunden	49	0	22	72				2	1			2	3	8	4	2		
HST	Mikkelborg			7	7										none				
HST	Bredelte	3			3										none				
HST	Hørsholm Slotshave	5		15	19									1	1	1			
HST	Bistrup Hegn	42	3	4	48	7			3				1	2	6	3	2		
HST	Stumpedysse Hegn	10	4	1	15										none				
HST	Sjælsø Lund	54	18	7	79		7		2				1	2	5	4	3		
VSJ	Grønnehave Skov	45		5	49				3				1		4	3	3		
VSJ	Annebjerg Skov	147	25	32	203	2	1		2				1	3	6	4	2		
VSJ	Nakke Skov	38	4	26	68				6		1		2	9	18	13	6		
VSJ	Højby Sø	3		56	59										none				
VSJ	Skansehage			16	16				2					7	9	8	1		
VSJ	Øer på søterritoriet			0	0										none				
VSJ	Nygård Sø			33	33				1					3	4	3	1		
VSJ	Ulkerup Skov	192	33	66	291		4		5				4		9	6	6		11
VSJ	Stokkebjerg Skov	64	1	8	73				1						1	1	1		
VSJ	Grevinge Skov	187	32	12	231				3		1				4	3	3		
VSJ	Hønsehals Skov	35	19	40	94	4	5		2				1	3	6	5	3		
VSJ	Bognæs Skov	28	10	13	51				1				1		2	1	1		
VSJ	Mosemark Skov	26	22	5	53										none				
VSJ	Øer på søterritoriet			1	1										none				
VSJ	Ellinge Indhegning	21	97	8	126									1	1	1			
VSJ	Jyderup Skov	70	131	12	213				3					2	5	4	2		

Forests always in zone 1 (N = 681) **S7 Table**

Dist	Forest name	Area (ha) Decid	Conif	Unwood	Total	% already in z3	in z4	Number of species from each zone group z2	z3	z4	z23	z24	z34	non-forest	Total	Priority A species All	Forest	% of obs already in z3	in z4
VSJ	Bjergene			90	90				3					17	20	19	2		
VSJ	Vollerup Skov	129	41	35	205				3					2	5	4	2		
VSJ	Klosterskov	77	10	35	122				5		1			4	10	7	4		
VSJ	Overby Lyng	1	2	12	15				2					6	8	6	1		
VSJ	Stenstrup Troldstue			0	0										none				
VSJ	Lærkereden			7	7										none				
VSJ	Veddinge Bakker			5	5										none				
VSJ	Sydspids af Sejerø			7	7				1						1	1	1		
VSJ	Gravhøj ved Svebøll				0										none				
VSJ	Vestborgen			2	2										none				
VSJ	Stenhus i Kalundbor			0	0										none				
VSJ	Øer på søterritoriet			0	0										none				
VSJ	Vrangeskov	32	19	3	54									1	1	1			
VSJ	Fællesfolden			96	96				2				4	10	16	9	3		
VSJ	Svallerup Strand			1	1										none				
VSJ	Langesø Eng			4	4										none				
VSJ	Langdysse ved Viels			0	0										none				
VSJ	Knud Lavards Kapel			0	0										none				
VSJ	Tadre Mølle			13	13										none				
VSJ	Øer på søterritoriet			2	2										none				
VSJ	Fugledegaard			72	72									1	1	1			
VSJ	Pedersted Skov	26	2	1	29										none				
VSJ	Stubberup Skov	5			5										none				
VSJ	Kattinge Søerne			86	86				2		1			4	7	4	1		
VSJ	Gershøj			2	2										none				
VSJ	Arealer ved Ejby			4	4										none				
VSJ	Arealer ved Gamme			58	58				2						2	2	2		
VSJ	Høng Skov	39	4	10	54				1					1	2	2	1		
VSJ	Benløse Skov	28	2	22	53				1					2	3	2	1		
VSJ	Skovrejsning Slagels			34	34										none				
NSJ	Brødemose skov	47	9	15	70				1				2		3	1	1		
NSJ	Avderød skov	57	6	8	70		1		4					3	7	6	4		
NSJ	Holstrupgård	1		43	44										none				
NSJ	Fuglsanggård	1		63	64									6	6	4			
NSJ	Kanalerne	2		6	8										none				
NSJ	Nordhuse	2		10	11				2						2	2	2		
NSJ	Arrenæs-arealer	10	6	158	175				5					3	8	7	5		
NSJ	Statens tørvemose	7		0	7		61								none				
NSJ	Hyttegården			6	6										none				
NSJ	Hovgårds pynt			4	4										none				
NSJ	Holløse bredning			86	86				5				2	10	17	7	3		
NSJ	Alsønderup enge			57	57				4				2	5	11	4	2		
NSJ	Solbjerg enge			57	57				6				2	8	16	4	2		
NSJ	Lyngby mose			55	55										none				
NSJ	Ullerup skov	71	10	20	101				9		2		5	5	21	12	8		
NSJ	Sandflugtsplantager	2	10	1	13										none				
NSJ	Hyllingbjerg	0		3	3									2	2	2			
NSJ	Stejlepladserne			6	6									2	2	2			
NSJ	Skansen			0	0						1				1				
NSJ	Sandflugtsmonumei			1	1										none				
NSJ	Helenekilde			0	0										none				
NSJ	Strandbjerggård	1	5	13	19									1	1	1			
NSJ	Vieholmgård			14	14										none				
NSJ	Rågegården	8	1	5	13									2	2	2			
NSJ	Gilbjerggård	1	2	37	40			1	9		2		4	20	36	23	8		
NSJ	Valby Hegn	267	63	30	360	0	5		6			1	6	3	16	11	8		6
NSJ	Høbjerg hegn	137	9	6	151				2				2	2	6	4	2		
NSJ	Nejede vesterskov	88	12	7	107	49	48		4		1		4	4	13	5	3	99	1
NSJ	Æbelholt klosterruir			1	1										none				
NSJ	Skævinge	53	23	143	219				1					1	2	2	1		
NSJ	Gørløse	24	4	101	129										none				
NSJ	Søborg Slotsruin			11	11										none				
NSJ	Klosterhus			0	0										none				

Forests always in zone 1 (N = 681) **S7 Table**

			Area (ha)			% already		Number of species from each zone group								Priority A species		% of obs already	
Dist	Forest name	Decid	Conif	Unwood	Total	in z3	in z4	z2	z3	z4	z23	z24	z34	non-forest	Total	All	Forest	in z3	in z4
NSJ	Esrum Kanal			5	5										none				
NSJ	Parcel i Nødebo			0	0										none				
NSJ	Sørup Havn			1	1										none				
NSJ	Fredensborg Havn			2	2										none				
NSJ	Nødebo Holt	45	3	2	49	96	4						6	2	8	1	1	100	
NSJ	Gadevang Skov	97	50	14	160				2		2		6	4	14	4	3		
NSJ	Selskov	44	2	1	47				1				1		2	1	1		
NSJ	Mose i Gadevang	1		0	1								1	1	2				
NSJ	Tirsdagsskoven	13		1	14										none				
NSJ	Brøde Skov	143	23	14	179	1	0		2				1	4	7	3	1		
NSJ	Lille Hestehave	13		24	37	23	76		1				2		3	3	3	33	33
NSJ	Snevret	50	8	10	67	19	24		1					3	4	1	1		
NSJ	Horneby Sand	9	10	51	70									1	1	1			
NSJ	Risby Vang	59	5	3	66						1			1	2				
NSJ	Krogenberg Hegn	154	72	25	251	4			5		2	1	2	1	11	6	6	9	
NSJ	Munkegårds Hegn	21		0	22									1	1				
NSJ	Endrup Hegn	27	6	1	34				1						1				
NSJ	Kelleris Hegn	54	8	3	65	2			1					1	2	2	1		
NSJ	Dageløkke Skov	24	2	34	59										none				
NSJ	Skipperholm	7		3	10	59	19								none				
NSJ	Kovang	5			5										none				
NSJ	Knorrenborg Vang	67	12	30	109				3		1		1	2	7	3	2		
NSJ	Grønholt Vang	164	27	45	236	8	12		6		1		8	1	16	7	6	2	8
NSJ	Grønholt Hegn	183	42	48	273		2		1			1	4	1	7	2	2		
NSJ	Stasevang	51	14	8	72		1		1			1	2	1	5	2	2		
OSJ	Farum Sø			125	125				3				1	6	10	5	2		
OSJ	Nyvang	35	14	11	59	16			5				2	5	12	11	6	60	
OSJ	Skydebanearealerne	2		11	13										none				
OSJ	Ganløse Forte			1	1										none				
OSJ	Brudehøje			0	0				1						1	1	1		
OSJ	Kollekolle	19	1	84	104	5			1				1	1	3			33	
OSJ	Snubbekorsskoven			13	13				1						1	1	1		
OSJ	Karlstrup Skov	43	12	154	208	1			5				2	8	15	10	4		
OSJ	Øer i Køge Bugt			63	63				1		1			26	28	17	1		
OSJ	Regnemark			11	11				1					2	3	3	1		
OSJ	Ramsø			12	12				2					5	7	2	1		
OSJ	Greve Skov	60	13	38	111										none				
OSJ	Solhøj Fælled	3	7	104	113				1						1	1	1		
OSJ	Tune Skov	30	3	54	87				1						1	1	1		
OSJ	Kildebrønde Skov			10	10										none				
OSJ	Sønderskov	25	9	10	44	17			3				5	4	12	5	3		
OSJ	Lystrup Skov	138	18	43	199	2			1				2	1	4	4	3		
OSJ	Uggeløse skov	124	17	20	162	3	5		5				3	6	14	10	4		
OSJ	Krogenlund	51	2	23	76		17		6	1			4	8	19	15	7		11
OSJ	Bastrup sø			42	42				2					8	10	8	2		
OSJ	Hammergård m.m.	5	0	11	16										none				
OSJ	Sperrestrup skov	79	6	31	116										none				
OSJ	Grønlien skov	37	6	10	52				3						3	3	3		
OSJ	Hørup Skov	7		45	51				1						1	1	1		
OSJ	Gulddysse Skov	72	8	40	121				5						5	4	4		
OSJ	Himmelev Skov	37	19	84	140				4					4	8	6	3		
	total	14274	12525	28070	54869														

S8 Table

S8 Table. Results of scenarios.

Scenario	z1 area %	z2 area %	z3 area %	z4 area %	cost% annual	z4 (ha)	z4 (n)	ATA	Target met (of 304 species)
A	25.9	24.3	28.2	21.7	61.3	22,933	78	0.83	217
B	26.9	23.6	29.2	20.3	61.4	21,541	75	0.84	215
C	39.3	0	38.2	22.5	68.7	23,797	85	0.87	199
D	39.3	0	38.2	22.5	68.7	23,807	88	0.87	199
E	37.1	20.3	25.1	17.5	53.0	18,502	59	0.86	229
F	38.3	19.7	25.6	16.5	53.6	17,424	60	0.87	232
G	**57.8**	**13.7**	**15.2**	**13.3**	**36.9**	**14,094**	**43**	**0.91**	**257**
H	**58.2**	**13.4**	**15.6**	**12.8**	**37.1**	**13,519**	**45**	**0.91**	**257**
I	25.9	24.3	29.5	20.4	53.9	21,573	70	0.83	217
J	26.9	23.6	30.3	19.2	53.5	20,302	70	0.84	215
K	39.3	0	40.3	20.4	58.4	21,577	73	0.87	199
L	39.3	0	40.6	20.1	58.4	21,241	73	0.87	199
M	37.1	20.3	27.7	14.9	45.6	15,803	44	0.86	229
N	38.3	19.7	28.1	14.0	45.9	14,810	44	0.87	232
O	**57.9**	**13.1**	**18.8**	**10.2**	**32.6**	**10,763**	**40**	**0.92**	**261**
P	**58.2**	**13.0**	**19.5**	**9.4**	**32.4**	**9,964**	**35**	**0.92**	**262**
Q	36.7	20.3	28.6	14.4	46.1	15,281	50	0.87	231
R	38.1	19.7	27.3	15.0	46.5	15,878	49	0.88	230
S	26.0	24.2	29.3	20.5	50.3	21,693	74	0.85	221
T	**35.8**	**24.3**	**23.5**	**16.4**	**42.7**	**17,338**	**61**	**0.90**	**255**
U	36.7	20.3	28.6	14.4	45.5	15,281	50	0.87	231
V	**58.0**	**13.0**	**19.1**	**9.9**	**30.5**	**10,524**	**39**	**0.91**	**258**
W	26.0	24.2	29.3	20.5	42.9	21,693	74	0.85	221
X	**35.8**	**24.3**	**23.5**	**16.4**	**36.3**	**17,338**	**61**	**0.90**	**255**
Y	36.7	20.3	28.6	14.4	38.1	15,281	50	0.87	231
Z	**58.0**	**13.0**	**19.1**	**9.9**	**25.5**	**10,524**	**39**	**0.91**	**258**
Q1	57.2	15.5	15.2	12.1	33.1	12,771	33	0.93	166
Q2	46.5	9.4	19.4	24.7	48.1	26,119	69	NA	NA
Q3	46.5	0	0	53.5	58.9	56,679	203	NA	NA

Lines in bold *are scenarios with target set at 3 representations instead of 5. See table 4 and 7 for other assumptions for each scenario. ATA = average target achievement for the priority A species included in the scenario. z = zone. NA = not applicable. All area measures deal with woodland area, i.e. excluding unwooded areas like grasslands etc.*

Gap species of scenario Q (N = 73) **S9 Table** Page 1 of 1

Taxon	Species name	Threat geography	Red list	De-cline?	Prio-rity	Main affinity	Saproxylic?	Group	Zone	Forests (N)	Match	gap_Q?
Mammalia	Barbastella barbastellus	EU	VU	no	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Coleoptera	Allecula morio	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	3	1	0	gap1
Coleoptera	Ampedus hjorti	Globally	VU	no	A	Deciduous	Saproxylic	Open saproxylic	3	5	3	gap2
Coleoptera	Crepidophorus mutilatus	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	3	5	3	gap2
Coleoptera	Gnorimus nobilis	Denmark	CR	yes	A	Deciduous	Saproxylic	Open saproxylic	3	1	0	gap1
Coleoptera	Ischnodes sanguinicollis	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	3	1	0	gap1
Coleoptera	Lucanus cervus	Denmark	RE	RE	A	Deciduous	Saproxylic	Open saproxylic	3	2	0	gap2
Coleoptera	Stictoleptura scutellata	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	12	4	gap1
Coleoptera	Tachyta nana	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	3	1	0	gap1
Diptera	Caliprobola speciosa	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	1	gap1
Diptera	Chalcosyrphus valgus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	4	2	gap2
Diptera	Cheilosia frontalis	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Diptera	Criorhina floccosa	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	5	4	gap1
Diptera	Cyrtopogon lateralis	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	1	gap1
Diptera	Epistrophe grossulariae	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	2	gap2
Diptera	Eumerus ornatus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	1	gap1
Diptera	Laphria ephippium	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	4	1	gap3
Diptera	Microdon analis	Denmark	VU	yes	A	Deciduous	Saproxylic	Open saproxylic	34	6	4	gap1
Diptera	Xanthogramma festivum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	3	gap2
Diptera	Xylota abiens	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	3	2	gap1
Hymenoptera	Formicoxenus nitidulus	Globally	VU	no	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	5	3	gap2
Lepidoptera	Boloria euphrosyne	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	7	4	gap1
Lepidoptera	Brachionycha nubeculosa	Denmark	RE	RE	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Lepidoptera	Calliteara abietis	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	3	0	gap3
Lepidoptera	Cosmia affinis	Denmark	RE	RE	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Lepidoptera	Herminia tarsicrinalis	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Lepidoptera	Nudaria mundana	Denmark	CR	yes	A	Conifer facultative	Non-saproxylic	Conifer facultative	23	4	3	gap1
Lepidoptera	Nymphalis polychloros	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	3	gap2
Lepidoptera	Xestia ditrapezium	Denmark	RE	RE	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Orthoptera	Chorthippus dorsatus	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	1	gap3
Araneae	Araneus alsine	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	1	gap1
Araneae	Midia midas	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Ascomycota	Gyromitra gigas	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	3	1	gap2
Basidiomycota	Camarophyllopsis atropuncta	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Basidiomycota	Clavaria flavipes	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	6	4	gap1
Basidiomycota	Crepidotus cinnabarinus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	1	0	gap1
Basidiomycota	Entoloma aprile	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	2	gap2
Basidiomycota	Entoloma formosum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	4	gap1
Basidiomycota	Entoloma lampropus	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultative	23	3	2	gap1
Basidiomycota	Entoloma queletii	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Untouched decid	4	2	0	gap2
Basidiomycota	Exidia cartilaginea	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	4	3	gap1
Basidiomycota	Flammulaster limulatus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	4	3	gap1
Basidiomycota	Gloeoporus dichrous	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	5	2	gap3
Basidiomycota	Hemipholiota heteroclita	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	5	4	gap1
Basidiomycota	Hypholoma ericaeum	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Basidiomycota	Inocybe sambucina	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	2	1	gap1
Basidiomycota	Lactarius albocarneus	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	7	2	gap3
Basidiomycota	Lactarius hysginus	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	2	1	gap1
Basidiomycota	Phellinus laevigatus	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	1	gap1
Basidiomycota	Polyporus melanopus	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	5	4	gap1
Basidiomycota	Ramaria fennica	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Other decidous	34	2	1	gap1
Basidiomycota	Rugosomyces chrysenteron	Denmark	EN	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	2	1	gap1
Basidiomycota	Russula rhodopus	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	4	3	gap1
Basidiomycota	Sarcodon scabrosus	Denmark	CR	yes	A	Conifer facultative	Non-saproxylic	Conifer facultative	23	4	3	gap1
Basidiomycota	Tomentella lateritia	Denmark	VU	yes	A	Deciduous	Saproxylic	Woodland saprox	4	3	1	gap2
Basidiomycota	Trametes suaveolens	Denmark	EN	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	1	gap1
Basidiomycota	Tricholoma aurantium	Denmark	EN	yes	A	Conifer facultative	Non-saproxylic	Conifer facultative	23	6	3	gap2
Basidiomycota	Tricholoma inamoenum	Denmark	VU	yes	A	Conifer obligate	Non-saproxylic	Conifer obligate	2	3	1	gap2
Basidiomycota	Xylobolus frustulatus	Denmark	CR	yes	A	Deciduous	Saproxylic	Woodland saprox	4	2	1	gap1
Lichen	Anisomeridium polypori	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Lichen	Cladonia incrassata	Denmark	CR	yes	A	Conifer facultative	Non-saproxylic	Conifer facultative	23	1	0	gap1
Lichen	Cladonia novochlorophaea	Denmark	VU	yes	A	Conifer facultative	Non-saproxylic	Conifer facultative	23	3	2	gap1
Lichen	Cladonia sulphurina	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	4	gap1
Lichen	Melanohalea elegantula	Denmark	EN	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	0	gap2
Lichen	Mycocalicium subtile	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	1	0	gap1
Tracheophyta	Bromus racemosus	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	3	2	gap1
Tracheophyta	Cypripedium calceolus	EU	VU	no	A	Deciduous	Non-saproxylic	Open woodland	3	2	1	gap1
Tracheophyta	Dianthus armeria	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Tracheophyta	Melampyrum cristatum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	3	gap1
Tracheophyta	Melampyrum nemorosum	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	1	gap1
Tracheophyta	Pulmonaria officinalis	Denmark	VU	yes	A	Deciduous	Non-saproxylic	Open woodland	3	4	2	gap2
Tracheophyta	Sorbus hybrida	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	5	4	gap1
Tracheophyta	Viola epipsila	Denmark	CR	yes	A	Deciduous	Non-saproxylic	Open woodland	3	2	0	gap2

CHAPTER 3

Identifikation af arter og naturtyper i 2020 biodiversitets målene

- Med særligt henblik på Naturstyrelsens arealer

Erik Buchwald & Jacob Heilmann-Clausen

(September 2016)

Previous page: Lepus europaeus (photo by Erik Buchwald)

UNIVERSITY OF COPENHAGEN
NATURAL HISTORY MUSEUM OF DENMARK
CENTER FOR MACROECOLOGY, EVOLUTION AND CLIMATE

Identifikation af arter og naturtyper i 2020 biodiversitets målene.

Med særligt henblik på Naturstyrelsens arealer.

Erik Buchwald & Jacob Heilmann-Clausen

September 2016

Titel	**Identifikation af arter og naturtyper i 2020 biodiversitets målene.** Med særligt henblik på Naturstyrelsens arealer.
Kontekst	Rapporten er udarbejdet som led i Erhvervs-PhD-projektet: "Analyse og prioritering af fremtidig indsats for biodiversitet - med særligt henblik på Naturstyrelsens arealer". Projektet løber 2015-18 og har til formål at undersøge og analysere, hvor og hvordan man i Danmark kan gøre en effektiv indsats for at hindre tab af biodiversitet – særligt på de ca. 2.000 kvadratkilometer af Danmark, som forvaltes af Naturstyrelsen.
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Dato	20. september 2016
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Layout	Lotte Nymark Busch Jensen, Erik Buchwald
Forsidefoto	Engperlemorsommerfugl på blåhat, taffeland, leverurt og kystklint på Romsø (alle fotos: Erik Buchwald)
Sideantal	30

Indholdsfortegnelse

Indledning

Denne rapport er udarbejdet som led i Erhvervs-PhD-projektet: "Analyse og prioritering af fremtidig indsats for biodiversitet - med særligt henblik på Naturstyrelsens arealer". Projektet løber 2015-18 og har til formål at undersøge og analysere, hvor og hvordan man i Danmark kan gøre en effektiv indsats for at hindre tab af biodiversitet – særligt på de ca. 2.000 kvadratkilometer af Danmark, som forvaltes af Naturstyrelsen (NST).

Politisk har de fleste af verdens lande, herunder Danmark, ved aftaler under Biodiversitets-Konventionen forpligtet sig til at standse tilbagegangen i biodiversitet. Der er i den forbindelse opstillet specificerede mål for år 2020 både på EU-niveau og globalt i FN-regi. Målene omhandler bl.a. indsats for truede arter, så deres udryddelse forebygges. Truede arter listes i den såkaldte rødliste fordelt på tre kategorier CR (kritisk truet), EN (moderat truet) og VU (sårbar), afhængigt af hvor truet arten vurderes at være. Desuden er kategorien RE (regionalt uddød) relevant, i det omfang sådanne arter dukker op igen.

Projektet vil især for Naturstyrelsens arealer analysere og prioritere de truede arter og deres konkrete levesteder i forhold til viden om arternes økologiske behov, udbredelse og klimakrav, relation til driftsformer, samt hidtidige udvikling. Fokus er på arter, som ser ud til at være af særlig betydning for, at Danmark kan nå det politisk vedtagne 2020-mål om at standse tabet i biodiversitet.

Nærværende rapport identificerer som en del af processen, hvilke arter og naturtyper, som er af betydning for, at Danmark kan nå 2020-målene. Det sker populært sagt ved at regne baglæns fra målene - i det omfang det kan lade sig gøre. Hvordan der skal prioriteres mellem disse arter og tilknyttede naturtyper for at nå 2020-målene vil være et væsentligt emne i resten af PhD-projektet.

Opgave afgrænsning

Arter omfattes, som er truede globalt, nationalt eller på Natura 2000 direktivernes bilag (ynglefugle bilag 1; habitat bilag 2, 4 og 5). Erhvervs-PhD-projektet og dermed denne opgave ser dog kun på de mere eller mindre terrestriske arter og naturtyper. Dvs. fuldt akvatiske arter i hav, sø og å er udeladt. Akvatiske arter, som tidvis er på land (amfibiske arter) medtages, såfremt en eller flere arter i familien er medtaget på habitatdirektivets bilag. Derfor er fx fisk, hvaler, slørvinger og døgnfluer ikke behandlet, mens bl.a. sæler, frøer, salamandre, vandkalve og guldsmede behandles.

FN- og EU- 2020-mål relevante for identifikation af arter og naturtyper

Danmark har politisk forpligtet sig til at arbejde for at standse tilbagegangen i biodiversitet inden 2020, dels i FN regi, dels i EU regi. I **FN regi** drejer det sig mere konkret om COP 10 vedtagelsen af 20 Aichi mål i Nagoya i 2010. I **EU regi** gælder det biodiversitetsstrategien fra 2011 indeholdende 6 specificerede mål, som skal sikre at EU-landene lever op til det overordnede globale mål og til de 20 Aichi mål.

Mange af målene er overordnede, generelle eller fokuserede på andre emner, så de ikke direkte kan relateres til konkrete arter eller naturtyper. Det vurderes at gælde de mål, som listes sidst i dette afsnit. Nedenfor tages derfor udgangspunkt i de mål, som er mere konkrete i relation til arter og naturtyper.

Natura 2000 - fugle, arter og naturtyper

I **EU regi** gælder det biodiversitetsstrategiens mål nr. 1 og 3, som handler om inden 2020 at forbedre status for Natura 2000 naturtyper, arter og fugle jf. følgende tabel (jf EU's impact assessment til strategien, dokument SEC(2011) 540 final af 3/5 2011):

Delmål for gunstig status	Basis (2004 - 2007)	Mål 2020	Stigning, afrundet
Natura 2000 naturtyper	17%	33%	100%
Natura 2000 arter	17%	25%	50%
Fuglearter	52%	80%	50%

For Natura 2000 *naturtyperne* er målet således, at der i 2020 skal være 100% flere typer med god eller forbedret status sammenlignet med vurderingen i 2007. Det betyder at:

- Tallet skal stige fra 17% til 33% for Natura 2000 naturtyperne.
- Det svarer ifølge EU til 100% forbedring efter afrunding.

For Natura 2000 *arter og fugle*, er målet, at der i 2020 skal være 50% flere med god eller forbedret status sammenlignet med de forrige vurderinger (i 2004 for fugle henholdsvis 2007 for andre arter). Det betyder at:

- Tallet skal stige fra 17% til 25% for Natura 2000 arter, og
- Stige fra 52% til 80% for fugle.
- Begge ændringer svarer ifølge EU til 50% forbedring efter afrunding.

Alle tallene er opgjort i de biogeografiske regioner, og ikke pr land. Det medfører, at tallene ikke direkte kan oversættes til nationalt niveau, men i praksis vil være forventet minimum for hvert enkelt land, idet alle, eller i hvert fald flertallet af lande, er nødt til at opnå positiv status for at EU samlet kan få det på regionsniveau.

EU's mål 3, om at der bl.a. skal laves driftsplaner for offentlige skove inden 2020, som skal bidrage til at forbedre status for arter og naturtyper omfattet af mål nr 1, understøtter, at det er arter og naturtyper fra habitat- og fugledirektiverne, målopfyldelsen skal vurderes på.

Truede arter

I **FN regi** går Aichi mål nr. 12 ud på at undgå uddøen af truede arter (dvs rødliste kategorierne CR kritisk truet, EN moderat truet og VU sårbar) inden 2020, og at forbedre arternes status: "By 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained".

Mål nr. 12 har nogle valgfri forslag til milepæle (teknisk baggrundsdokument COP/10/INF/12/Rev.1):

- Inden 2012 vurdere og opdatere information om *globalt* truede arters forekomst i landet, samt aktivt forebygge deres kortsigtede uddøen.
- Inden 2014 gennemføre en *national* rødliste vurdering.
- Inden 2016 udarbejde en strategi til forebyggelse af uddøen af alle *nationalt* truede arter.

Det er således arter, som er truede på enten globalt eller nationalt niveau, der er i fokus for mål nr. 12, samt genopdukkede regionalt uddøde arter, kategori RE.

Invasive arter

EU mål nr 5 og FN mål nr 9 går ud på at få identificeret og forvaltet invasive fremmede arter inden 2020. Invasive fremmede arter er dermed i fokus både i EU- og FN-regi. EU har efterfølgende vedtaget en liste med invasive arter på EU-niveau. En foreløbig dansk "sortliste" arbejdes der på at gøre endelig, mens en liste over arter opfattet invasive i forhold til Natura 2000 naturtyper har foreligget i en årrække.

Invasive arter behandles ikke yderligere i nærværende rapport, idet der henvises til de nævnte officielle lister (http://svana.dk/natur/national-naturbeskyttelse/invasive-arter/).

Mål, som ikke bidrager til identifikation af arter og naturtyper

Følgende EU og FN mål er ikke specifikke med hensyn til konkrete arter eller naturtyper, idet de er mere overordnede:

EU mål nr 2 (økosystem genopretning og ydelser), 4 (fiskeri) og 6 (global indsats og handel).

FN mål nr 1 (formidling), nr 2 (plan og processer), nr 3 (tilskud), nr 4 (bæredygtig produktion og forbrug), nr 5 (standse fald i naturareal), nr 6 (undgå overfiskeri), nr 7 (bæredygtig skovforvaltning), nr 8 (forurening), nr 10 (koralrev og klimaforandringer), nr 11 (17% af landarealet naturbeskyttet), nr 13 (kulturplante genetik), nr 14 (økosystemydelser), nr 15 (kulstoflagre og klimatilpasning), nr 16 (access and benefit sharing), nr 17 (national biodiversitets strategi), nr 18 (inddragelse af indfødte folk), nr 19 (videnopbygning og -deling), samt nr 20 (finansiering).

Som følge af opgaveafgrænsningen er marine arter, herunder fisk, udeladt. Hvis marine arter havde været med, kunne EU mål 4 og FN mål 6 om fiskeri have været analyseret nærmere for om der eventuelt kunne identificeres relevante arter.

Proces

Udfra ovenstående mål, udredes i de følgende kapitler hvilke arter og naturtyper, der omfattes af henholdsvis EU og FN mål, og potentielt kan forekomme på NST arealer, samt hvilke af arterne og typerne, der ser ud til at kunne få størst indflydelse på målopfyldelsen i 2020 (ved populært sagt at regne baglæns fra målene).

Arter og naturtyper, som kan påvirke opfyldelsen af EU's 2020 biodiversitets mål, og som kan forvaltes på NST arealer

I ovenstående kapitel fremgik det, at **EU** biodiversitetsstrategiens mål nr. 1, som handler om inden 2020 at forbedre status for Natura 2000 naturtyper, arter og fugle, er det afgørende mål i relation til identifikation af arter og naturtyper. Det drejer sig om arter på habitatdirektivets bilag (nr 2, 4 og 5) og om fugle omfattet af fuglebeskyttelsesdirektivet, dvs alle vilde fuglearter.

ARTER PÅ HABITATDIREKTIVET

For at give et indtryk af, hvor Danmark ligger i forhold til EU, kan følgende tal med visse forbehold sammenlignes. De danske tal baseres på de 130 regionale artsvurderinger for 83 arter, som blev rapporteret til EU i 2013 (tabel 1), link:
http://cdr.eionet.europa.eu/Converters/run_conversion?file=dk/eu/art17/envuqrtva/DK_species_reports-131220-95922.xml&conv=354&source=remote

Tabel 1 Natura 2000 **arter**	EU 2007 snit	Danmark 2007	Danmark 2013	EU 2020 mål
	%	%	%	%
Gunstig	17	24	30	20
Forbedringer	Ikke opgjort	Ikke opgjort	Ikke opgjort	5
Moderat ugunstig	30	9	12	Ikke opgjort
Stærkt ugunstig	22	25	27	Ikke opgjort
Ukendt	31	18 (+24 mangler)	31	Ikke opgjort
I alt procent	100	100	100	

Der er (ekskl. den genudsatte bæver) 82 arter fra habitatdirektivets bilag 2, 4 eller 5, som findes i Danmark ifølge 2013 rapporteringen til EU, og som dermed kan spille ind på opfyldelsen af EU's 2020 mål nummer 1. En række arter er rapporteret fra mere end en af Danmarks to biogeografiske regioner, så det samlede antal vurderinger er 130.

Af de 82 arter er 63 mere eller mindre terrestriske arter (inkl. vandhulsarter og sæler), hvor indsats kan være relevant, hvis de findes på NST arealer. De 63 arter listes artsgruppevis i rapportens bilag

1, 2, 3 og 4 med angivelse af om de har haft rapporteret ugunstig status i 2007 eller 2013, samt om de vurderes at forekomme på Naturstyrelsens arealer.

De øvrige er 19 fuldt akvatiske arter, som ikke omfattes af nærværende studie, jf. opgaveafgrænsningen. Det gælder 5 fuldt marine arter og 14 limniske arter (bilag 5).

De arter, som umiddelbart influerer på EU's 2020 mål ved (jf data i bilag 1 til 4) at have haft rapporteret ugunstig status i en eller begge regioner af Danmark i enten 2007 eller 2013, og som med større eller mindre sikkerhed findes på Naturstyrelsens arealer er uddraget og sammenstillet i henholdsvis tabel 2 og 3.

Tabel 2. Arter på habitatdirektivets bilag 2, 4 eller 5, som *vides at findes* på Naturstyrelsens arealer, og som har været rapporteret ugunstige til EU i mindst en region i enten 2007 eller 2013. I alt 29 arter. De fleste af arterne er sjældne og med få eller meget få forekomststeder, men nogle af arterne er mere udbredte. Arter på bilag 2 er også ofte på bilag 4 (ikke vist).

Kode	Navn	*Videnskabeligt navn*	Biotop	Bilag
1042	Stor kærguldsmed	*Leucorrhinia pectoralis*	vandhul	2
1037	Grøn kølleguldsmed	*Ophiogomphus cecilia*	vandløb	2
1048	Grøn mosaikguldsmed	*Aeshna viridis*	vandhul	4
1058	Sortplettet blåfugl	*Maculinea arion*	græsland	2
1065	Hedepletvinge	*Euphydryas aurinia*	græsland	2
1081	Bred vandkalv	*Dytiscus latissimus*	vandhul	2
1082	Lys skivevandkalv	*Graphoderus bilineatus*	vandhul	2
1084	Eremit	*Osmoderma eremita*	skov	2
1166	Stor vandsalamander	*Triturus cristatus*	vandhul	2
1188	Klokkefrø	*Bombina bombina*	vandhul	2
1197	Løgfrø	*Pelobates fuscus*	vandhul	4
1201	Grønbroget tudse	*Bufo viridis = Bufotes variabilis*	vandhul	4
1202	Strandtudse	*Bufo calamita = Epidalea calamita*	vandhul	4
1203	Løvfrø	*Hyla arborea*	vandhul	4
1210	Grøn frø	*Rana esculenta = Pelophylax esculentus*	vandhul	5
1212	Latterfrø	*Rana ridibunda = Pelophylax ridibundus*	vandhul	4
1214	Spidssnudet frø	*Rana arvalis*	vandhul	4
1261	Markfirben	*Lacerta agilis*	græsland	4

1308	Bredøret flagermus	*Barbastella barbastellus*	skov	2
5009	Dværgflagermus	*Pipistrellus pygmaeus*	skov	4
1323	Bechsteins flagermus	*Myotis bechsteinii*	skov	2
1341	Hasselmus	*Muscardinus avellanarius*	skov	4
1355	Odder	*Lutra lutra*	vand	2
1378	Rensdyrlav	*Cladonia spp. (subgenus Cladina)*	græsland	5
1386	Grøn buxbaumia	*Buxbaumia viridis*	skov	2
1409	Tørvemos (alle arter)	*Sphagnum spp.*	mose	5
1831	Vandranke	*Luronium natans*	vand	2
1902	Fruesko	*Cypripedium calceolus*	kalkbund	2
1903	Mygblomst	*Liparis loeselii*	græsland	2

Det fremgår af kolonnen Biotop, at 13 af de 29 arter hører til vandhuller, 6 arter hører til skov, 5 arter hører til græsland, og de sidste fem arter til mose, vand eller kalkbund. En lignende overvægt af vådområder fremgår af tabel 3, hvilket viser at forvaltning af vandhuller og andre vådområder kan være af særlig betydning. Dette mønster forstærkes, hvis man går et spadestik dybere og ser på om status er stærkt eller moderat ugunstig (ikke vist her).

En nærmere granskning af tilgængelige kilder vil sikkert vise, at også flere af arterne i tabel 3 findes på Naturstyrelsens arealer (målrettet eftersøgning i felten indgår ikke i projektet).

Tabel 3. Arter på habitatdirektivets bilag 2, 4 eller 5, som *måske findes* på Naturstyrelsens arealer, og som har været rapporteret ugunstige til EU i mindst en region i 2007 eller 2013. I alt 6 arter.

Kode	Navn	*Videnskabeligt navn*	Biotop
1013	Kildevældsvindelsnegl	*Vertigo geyeri*	Kilder
1014	Skæv vindelsnegl	*Vertigo angustior*	græsland
1343	Birkemus	*Sicista betulina*	græsland
1364	Gråsæl	*Halichoerus grypus*	Kyst
1393	Blank seglmos= Fedtet Krogmos	*Drepanocladus vernicosus=Hamatocaulis v.*	Kilder
1528	Gul stenbræk	*Saxifraga hirculus*	Kilder

Konklusion vedr. arter fra habitatdirektivet

Arterne på habitatdirektivets bilag 2, 4 og 5 analyseres nøjere for at se, hvor de findes på Naturstyrelsens arealer, og om drift og pleje af arealerne er passende eller kan forbedres for disse arter. Særlig fokus vil være på arterne i tabel 2 og 3.

For en række af arterne er der allerede gjort en stor og målrettet indsats, men der er sandsynligvis også en række lokaliteter, hvor der kunne gøres en ekstra indsats for arterne. Det gælder nok især for de arter, som ikke er på direktivets bilag 2, og derfor ikke har fået udpeget habitatområder eller fået lavet Natura 2000 planer.

NATURTYPER PÅ HABITATDIREKTIVET

De naturtyper, som omfattes af EU-målet for 2020 findes på habitatdirektivets bilag 1 og er dermed omfattet af Natura 2000 planer. Tabellen viser rapporterede vurderinger for de 60 danske habitattyper, som ofte har to vurderinger pr. type grundet to biogeografiske regioner (fra https://circabc.europa.eu/sd/a/ae61e78c-c1b1-46f4-abc3-ebf892b30c03/DK_20140528.pdf):

Conservation status of **habitats** Conservation status of **species**

■ FV - Favourable ■ NA - Not reported ■ XX - Unknown ■ U1 - Unfavourable inadequate ■ U2 - Unfavourable bad

Year of assessment	HABITATS					SPECIES				
	FV	NA	XX	U1	U2	FV	NA	XX	U1	U2
2007	18		26	11	53	36		20	17	35
2013	**6**		**5**	**24**	**76**	**39**		**31**	**15**	**32**

I 2013 var de få gunstige typer alle strandnære (Vadegræssamfund, forklit, strandvold og estuarie).

Alle fuldt terrestriske typer er rapporteret ugunstige til EU enten i 2007 eller 2013, hvorfor udmøntningen af Natura 2000 planer for naturtyper bl.a. på Naturstyrelsens arealer er vigtig for at forbedre status. De fleste af naturtyperne (bortset fra de marine) kan findes på NST arealer.

FUGLEBESKYTTELSESDIREKTIVETS ARTER

Ved seneste officielle danske rapport om fugle til EU i 2013 rapporteredes 230 poster, omfattende oplysninger om status og udvikling for 193 danske ynglefuglearter og 37 vintergæster, idet arter som både optræder som vintergæster og som ynglefugle (fx ederfugl) har to poster (http://bd.eionet.europa.eu/activities/Reporting/Article_12/Reports_2013/Member_State_Deliveries).

Da der er tale om en fælles EU-standard metode, er følgende tal sammenlignelige. De danske tal baseres på ovennævnte 230 officielt rapporterede artsvurderinger for fugle (tabel 4):

Tabel 4 **Fugle**	EU 2004 snit	Danmark 2004	Danmark 2013	EU 2020 mål
	%	%	% (siden 2000)	% (siden 2004)
Gunstig (stabil/fremgang)	52	Ikke opgjort	70	80
Ugunstig (tilbagegang)	48	Ikke opgjort	30	20
I alt procent	100	100	100	100

I Danmark er udviklingen siden 2000, jf tabel 4, stabil eller positiv for 70 procent af de rapporterede fugle. For resten (30 %) er udviklingen negativ siden 2000. De 30 % repræsenterer 67 artsvurderinger, som derfor vil influere negativt på 2020 målene, hvis udviklingen ikke vendes. Der er 3 af de 67 vurderinger, som omhandler marine vintergæster (fløjlsand, ederfugl og knortegås), hvorfor de i relation til nærværende projekt ikke er relevante.

Tilbage er 64 ynglefuglearter, som har vist tilbagegang siden 2000. Indsats for dem vil være relevant, herunder på NST arealer. De listes i bilag 6 og 7 alt efter om de også var ugunstige på EU-niveau i 2004 eller ej. Bilagene er derudover sorteret efter biotop og antal par.

Arter med stabil eller positiv udvikling siden 2000 vil ikke influere negativt på målene, hvis udviklingen fortsætter, hvilket kunne forventes, idet beskyttelsesniveauet ikke er forringet. Dog er enkelte af disse fugle truede på den danske rødliste 2010. Forebyggelse af fald i deres bestand kan være af betydning for EUs 2020 mål: Drosselrørsanger, markpiber, mosehornugle, hvidbrystet præstekrave, stor kobbersneppe, pirol og tinksmed. Pirol er skovfugl, de øvrige fra mere åbent land.

Det fremgår tilsvarende af bilag 6, at langt de fleste af arterne med tilbagegang både i Danmark og EU hører til i det åbne land, idet dette også gælder de to arter med biotop angivet som "diverse". De fire skovfugle, som er på bilag 6, hører ligesom pirol især til i lyse skove med skovlysninger. Bortset fra et par arter er både kort- og langtidstrenden negativ i bilag 6, både i Danmark og EU.

De fleste af arterne i bilag 7 er ligesom i bilag 6 ret talrige, således at det især vil være generelle forhold på landsplan og i EU, der vil være afgørende for deres udvikling. I tabel 5 listes de af fuglene fra bilag 6 – 7, som omfattes af denne rapports opgaveafgrænsning ved enten at være truede eller på fuglebeskyttelsesdirektivets bilag 1.

Tabel 5. Fugle som i Danmark er truede eller på fugledirektivets bilag 1, og som samtidig er rapporteret til EU som værende i tilbagegang siden 2000 (Ekskl den uddøde urfugl). Sorteret efter biotop og antal par.

	Trend 1980-2011	Primær biotop	Bilag 1-art?	Bestand (mindst)
Vendehals	-	skov		30
Vandstær	+	mose/sø/å		1
Pungmejse	Fluktuerer	mose/sø/å		6
Sortterne	-	mose/sø/å	ja	48
Sandterne	-	kyst	ja	1
Brushane	-	kyst	ja	43
Karmindompap	Fluktuerer	kyst		50
Engryle (almindelig ryle)	-	kyst	ja	135
Fjordterne	-	kyst	ja	420
Klyde	-	kyst	ja	2.400
Havterne	-	kyst	ja	4.500
Stor Tornskade	Stabil	hede		4
Hvid Stork	-	græsland	ja	1
Toplærke	-	agerland		2
Kirkeugle	-	agerland		43

Arterne i tabel 5 vil i forhold til opgaveafgrænsningen være de mest oplagte at fokusere på for at nå 2020-målene. Også øvrige arter på bilag 6 og 7 er af betydning for målopfyldelsen, selvom de hverken er truet ifølge rødlisten eller på fuglebeskyttelsesdirektivets bilag 1, og derfor udenfor opgaveafgrænsningen. Fx er duehøg, taffeland, grønspætte og ride også så fåtallige, at konkrete beskyttelses indsatser vil kunne forbedre landsudviklingen.

Konklusion vedr. arter fra fuglebeskyttelsesdirektivet

De mest oplagte fuglearter at gøre noget for på Naturstyrelsens arealer er listet i tabel 5, men alle vilde fuglearter kan influere på EU's 2020-mål. Alle truede og bilag 1-arter analyseres jf. opgaveafgrænsningen nøjere for at se, hvilken andel af landets bestand, der findes på styrelsens arealer, hvor de findes på Naturstyrelsens arealer, og om drift og pleje af arealerne er passende eller kan forbedres for disse arter. For en række af arterne er der allerede gjort en stor og målrettet indsats, men der er sandsynligvis også en række lokaliteter, hvor der kan gøres ekstra indsats. De mere talrige arter (resten af bilag 6 og 7) vil være vanskeligere at påvirke ved konkrete tiltag, idet deres bestands udvikling vil være mest afhængig af overordnede faktorer på landsplan.

Truede arter, som kan influere på opfyldelsen af FN's 2020 biodiversitets mål, og som kan forvaltes på NST arealer

Første kapitel gennemgik, at af **FNs** biodiversitets mål for 2020, er Aichi mål nr. 12 direkte relevant for artsforvaltningen, idet det går ud på at undgå uddøen af truede rødlistearter inden 2020, og at forbedre arternes status. Målet fokuserer særligt på de arter, som har haft størst tilbagegang, og har jf. første kapitel foreslåede milepæle for *globalt* truede arter og for *nationalt* truede arter.

Her ses derfor på henholdsvis globalt og nationalt truede arter i relation til de arealer, som Naturstyrelsen forvalter. De truede arter er CR (kritisk truet), EN (moderat truet) og VU (sårbar).

GLOBALT TRUEDE ARTER

Aichi mål nr. 12 har en foreslået milepæl om, at hvert land vurderer og opdaterer information om *globalt truede* arters forekomst i landet, samt aktivt forebygger deres kortsigtede uddøen.

Data for globalt truede arter kendt fra Danmark er hentet d. 8/5 2015 fra naturbeskyttelses-organisationen IUCN (permalink: http://www.iucnredlist.org/search/link/554c4d07-c8f7a9d9).

Tabel 6: Oversigt over de 36 globalt truede arter, som er noteret fra Danmark i IUCNs globale rødliste (maj 2015), samt velkendt forekomst i Danmark og på Naturstyrelsens arealer (F&N2015).

Status i Danmark	Antal arter	Arter hos NST	Antal steder i Danmark	Steder hos NST	Andel steder hos NST	Mere info
Terrestrisk ynglende arter	7	5	Ca. 97	Ca. 35	36 %	tabel 7
Ferskvands ynglende arter	8	4	Ca. 55	Ca. 14	25 %	tabel 8
Marint ynglende arter	6	0	0	0	0	bilag 8
Marine ikke-ynglende arter	12	0	0	0	0	bilag 9
Reelt ikke tilstede i Danmark	3	0	0	0	0	bilag 10
I alt	36	9	Ca. 152	Ca. 49	32 %	

Der kan på Naturstyrelsens arealer potentielt gøres relevant indsats for de 9 forekommende henholdsvis terrestriske og ferskvandsarter i tabel 7 og 8, men næppe for de marine eller kun tilfældigt tilstedeværende arter, hvor mere information er listet i bilag 8, 9 og 10.

De 6 arter i bilag 8 er havfisk, som yngler i danske farvande, og som ikke findes på Naturstyrelsens arealer. Arterne i bilag 9 er ikke-ynglende marine fugle, fisk og hvaler og derfor heller ikke relevante på Naturstyrelsens arealer. Ålen er dog en undtagelse, men den er primært truet af en parasiterende invasiv svømmeblæreorm, som så vidt vides ikke kan påvirkes ved arealforvaltning. Det er ikke i Danmark muligt (eller relevant) at gøre noget for de 3 arter i bilag 10, da arterne faktisk ikke eller kun helt tilfældigt har optrådt i Danmark.

Tabel 7: De i maj 2015 globalt truede *terrestriske arter* med yngleforekomst i Danmark, og deres velkendte forekomst, herunder på Naturstyrelsens arealer (NST).

Art	Latinsk navn	Global kategori	Dansk rødlistekategori	Forekomst i DK Kilde: Fugle & Natur + rødlisten + KU-mos-database (maj 2015)
Violsmælder	Limoniscus violaceus	EN	RE, forsvundet	3 ex fundet 1924 i ét træ på Bognæs
En art edderkop	Dolomedes plantarius	VU	VU, sårbar	Fundet 7 steder, heraf 5 NST
En art smælder	Ampedus hjorti	VU	LC, livskraftig	Fundet >27 steder, heraf 6 NST
Hede-Takspinder	Phyllodesma ilicifolia	VU	NT, næsten truet	Fundet >5 steder, heraf 3 NST
Blank gæstemyre	Formicoxenus nitidulus	VU	Myrer er ikke bedømt	Fundet >9 steder, heraf 5 NST
Bølgebladet tandsvøb	Jamesoniella undulifolia	VU	Mosser er ikke bedømt	Kun set 2 steder i 1865 og i Jelling Skov 1904.
Sump-vindelsnegl	Vertigo moulinsiana	VU	Snegle er ikke bedømt	Fundet >49 steder, heraf 16 NST

Det fremgår af tabel 7, at det ikke vil være muligt at gøre noget for violsmælder eller for mosset bølgebladet tandsvøb, idet de to arter ikke er set i Danmark i ca. 100 år. Derimod findes der på Naturstyrelsens arealer en relativt stor andel af flere af de andre arters bestande. En af arterne -

sump-vindelsnegl – er på habitatdirektivets bilag 2, og håndteres i forbindelse med EU's 2020 mål. Derudover vil de 4 resterende arter i tabel 7 skulle undersøges nærmere for at se på konkrete muligheder for at hjælpe dem på Naturstyrelsens arealer.

Tabel 8: De globalt truede *ferskvands arter* med yngleforekomst i Danmark, og deres forekomst, herunder på Naturstyrelsens arealer (NST).

Art	Latinsk navn (IUCN taxonomi)	Global kategori	Dansk rødlistekategori	Forekomst i DK Kilde: Fugle & Natur + rødlisten + DCE 2011 artsrapport
Holmegårds damvandkalv	*Agabus clypealis*	EN	Vandkalve er ikke bedømt	Kun kendt 1970-81 fra Holmegårds Mose, Westfalerskær. Ikke NST.
Flodperlemusling	*Margaritifera margaritifera*	EN	Muslinger er ikke bedømt	Kun kendt fra Varde Å. Senest i 1995 iflg NST 2013. Ikke NST.
Tykskallet malermusling	*Unio crassus*	EN	Muslinger er ikke bedømt	Fundet 15 steder, heraf 0 NST
Flad dammusling	*Pseudanodonta complanata*	VU	Muslinger er ikke bedømt	Fundet >4 steder, heraf 0 NST.
Bred vandkalv	*Dytiscus latissimus*	VU	Vandkalve er ikke bedømt	Findes >7 steder, heraf 6 NST
Lys skivevandkalv	*Graphoderus bilineatus*	VU	Vandkalve er ikke bedømt	Findes >5 steder, heraf 3 NST
Flodkrebs	*Astacus astacus*	VU	Krebsdyr er ikke bedømt	Findes >>23 steder, heraf >>5 NST. Udbredt og stedvis talrig.
Helt (inkl. snæbel)	*Coregonus maraena = C. lavaretus*	VU	LC, livskraftig (VU for snæbel)	Talrig i diverse jyske åer og fjorde (Snæbel kun i et par sydvestjyske åer)

Arterne i tabel 8 er fuldt akvatiske og derfor udenfor opgaveafgrænsningen, undtagen de tre vandkalvearter, som er amfibiske. Af vandkalvene er det kun de nederste 2, som findes på Naturstyrelsens arealer. De er begge på habitatdirektivets bilag 2 og håndteres derfor i forbindelse med EU's 2020 mål.

Den globale rødliste opdateres jævnligt. Artsudvalget fra 8/5 2015 lå til grund for dataindsamlingen til nærværende projekt. Efter 8/5 2015 og frem til 23/8 2016 er 11 arter tilføjet jf bilag 11 (5 marine, 3 svampe og 3 fugle). De tre svampe og nordisk lappedykker var i forvejen med i projektet fordi de er nationalt truede eller på EU-direktiv bilag. Det var taffeland og turteldue til gengæld ikke, så data for dem er ikke indsamlet i projektet, og vil derfor heller ikke indgå i projektets kommende analyser.

Konklusion vedr. globalt truede arter

Edderkoppen *Dolomedes plantarius* og de tre insekter *Ampedus hjorti, Phyllodesma ilicifolia* og *Formicoxenus nitidulus* i tabel 7 vil blive analyseret nærmere for at afklare, om de kan hjælpes på Naturstyrelsens arealer. Derudover medtages de 3 svampe og nordisk lappedykker, som er tilføjet som globalt sårbare siden maj 2015.

NATIONALT TRUEDE RØDLISTEARTER

Danmarks rødliste er senest opdateret i 2010, og næste opdatering forventes færdig i 2018 ifølge bogen *"Danmarks truede arter. Den danske Rødliste"* fra den ansvarlige institution, Århus Universitet, 2014. Bogen kaldes i det følgende for "Rødlistebogen 2014". Den beskriver og resumerer data fra rødliste 2010, som i form af en database ligger på følgende hjemmeside: http://bios.au.dk/videnudveksling/til-myndigheder-og-saerligt-interesserede/redlistframe/ .

Rødliste databasen har Naturstyrelsen fået tilsendt elektronisk fra DCE v/ Peter Wind d. 13. marts 2013. Databasen behandler 10.581 arter og har en række oplysninger om hver art. Der er dog ikke en liste med konkrete fund af arterne. Den følgende gennemgang er gennemført på baggrund af oplysningerne i den tilsendte fil, idet den er hurtigere at sortere og søge i, og ifølge DCE har identisk indhold med net-versionen.

Der skelnes i rødliste terminologi mellem en række kategorier, og kun en delmængde heraf kaldes for "rødlistede arter" = "rødlistearter", nemlig arter i kategorierne RE, CR, EN, VU, og NT (forsvundet, kritisk truet, moderat truet, sårbar og næsten truet). Ved bedømmelse af arter til rødlisten bruges også kategorierne LC, DD, NA og NE (ikke truet, utilstrækkelige data, vurdering ikke mulig og ikke bedømt), men de arter, som kommer i de kategorier kaldes ikke rødlistede arter.

De truede arter er en delmængde af rødlistearterne, og gælder kategorierne CR (kritisk truet), EN (moderat truet) og VU (sårbar). Det er dem Aichi mål 12 handler om. I alt er der 1526 truede arter på den danske rødliste, jf tabel 9 (summen af 369 CR, 496 EN og 661 VU). Desuden er kategorien RE (regionalt uddød) relevant, i det omfang sådanne arter dukker op igen.

Tabel 9. Oversigt over kategorier og arter i Danmarks hidtidige arbejde med rødlisten (fra rødlistebogen 2014). Procenter for kategorierne sættes i visse kilder i forhold til bedømte arter og i andre kilder til alle arter. Derfor vises her begge typer procenter.

RE	**CR**	**EN**	**VU**	**NT**	**Rødlistede arter i alt**	**LC**	**DD**	**Bedømte arter i alt**	**NA**	**NE**	**Arter i alt**
303	369	496	661	433	2262	5273	634	8169	2257	155	10581
4%	5%	6%	8%	5%	28%	65%	8%	100%	-	-	-
3%	3%	5%	6%	4%	21%	50%	6%	77%	21%	1%	100%

Det hidtidige arbejde med rødlisten har forholdt sig til 10.581 af Danmarks ca 35.000 arter. De arter, som ikke er behandlet er hovedsagelig artsgrupper med begrænset viden, herunder meget begrænset viden om bestandsudviklingen over tid, som er essentiel for at kunne rødlistevurdere en art. De fleste af de manglende er insekter (ca. 15.000 arter). Også mange svampe, samt alle mosser, alger, bløddyr og en række andre dårligt kendte grupper mangler bedømmelse.

Aichi mål 12 handler derfor om at forbedre forholdene og forhindre uddøen for de 1526 truede rødlistearter i tabel 9 (CR, EN og VU). For hver af arterne findes der i rødliste databasen oplysninger om artens forekomst i tid og rum, samt om bl.a. levesteder og trusler.

I forbindelse med denne rapport er der taget udgangspunkt i rødliste databasens oplysninger, og ikke indhentet supplerende oplysninger fra andre kilder. I PhD-projektet vil data fra en række andre kilder, herunder internettet (især fugleognatur.dk, miljoeportal.dk m.fl.) og Naturstyrelsens egne databaser blive anvendt til supplerende afklaring af, bl.a. hvor og hvornår arterne er fundet på Naturstyrelsens arealer.

For at kunne overskue de 1526 arter i forhold til Aichi målet er arterne indledningsvis ud fra oplysningerne i rødliste databasen sorteret efter følgende forhold:

- Om arten er i **tilbagegang** eller "blot" sjælden, hvilket fremgår af de kriterier, der har ført til, at arten blev vurderet truet. Aichi målet fokuserer nemlig på arter med tilbagegang, især dem med størst tilbagegang.
- **EU arter** herunder alle fugle er gennemgået og vurderet for sig i relation til EU's 2020 mål.
- **Marine arter** og andre fuldt akvatiske arter er jf. opgaveafgrænsningen frasorteret.

Tilbagegang eller ej

For hver art skal der ifølge manualen til rødlistning udfyldes hvilke kriterier, der begrunder rødlistekategorien for arten. Kriterierne A, B1b, B2b, C1 og C2 bruges for arter, som vides eller formodes at have været i eller kunne opleve fremtidig tilbagegang i bestand eller habitat (i større eller mindre grad). Modsætningsvis bruges kriterie D om arter, som er så sjældne og fåtallige, at det i sig selv gør dem truede, også selvom en aktuel tilbagegang ikke har kunnet påvises.

Rødliste databasen er ikke 100% konsistent udfyldt efter manualen, fx er kriterie ikke eller mangelfuldt udfyldt for en række arter. I de tilfælde er teksten i databasens felter for "National Status" og "Bestandsudvikling" brugt til at afgøre, om arten er i tilbagegang eller ej. Tilsvarende er data for udvikling over tid ofte mangelfulde eller helt manglende.

Af Danmarks 1526 truede arter er 908 ifølge rødlistens kriterier eller tekst truet grundet tilbagegang, mens resten (618 arter) ikke er noteret som truet af tilbagegang, men er så tilpas sjældne og lokale, at de af den grund er vurderet truede.

Mange af de truede arter, som ikke er registreret med tilbagegang i rødlisten, har altid været meget sjældne i Danmark eller har kun optrådt sporadisk eller uregelmæssigt. En del af dem er først fundet i Danmark i de senere årtier og kan derfor være arter under indvandring. Det vil blive analyseret nøjere i projektets videre faser, hvordan prioritering af arterne kan foretages.

EU arter

Alle fugle og en række andre arter håndteres af fuglebeskyttelsesdirektivet henholdsvis habitatdirektivet. Muligheder for at hjælpe de arter på Naturstyrelsens arealer er gennemgået i kapitlet om EU's 2020 mål. Det gælder 60 af de 1526 truede arter, idet de både er rødlistet som truede og omfattet af EU direktiverne. Heraf 30 med tilbagegang ifølge rødlistens oplysninger.

Marine arter, sø og å

Ifølge opgaveafgræsningen udelades fuldt akvatiske arter. Denne frasortering baseret på biotop resulterer samlet i at 4 arter i tilbagegang udgår af analysearbejdet.

Konklusion vedr. nationalt truede arter

Der er 1526 truede arter på den danske rødliste (summen af 369 CR, 496 EN og 661 VU). Desuden er kategorien RE (regionalt uddød) relevant, i det omfang sådanne arter dukker op igen.

Af de 1526 arter er der 874 ikke-akvatiske arter, som er vurderet til at være i tilbagegang, hvilket ifølge Aichi mål 12 bør medføre, at de gives ekstra prioritet i forvaltningen. Det vil blive analyseret nøjere i projektets videre forløb, hvordan oplysningerne om tilbagegang eller ej kan anvendes i forbindelse med prioritering af indsatsen med særligt henblik på Naturstyrelsens arealer.

Hvordan der skal prioriteres mellem de identificerede nationalt, globalt og EU-truede arter og tilknyttede naturtyper for at nå 2020-målene vil være et væsentligt emne i resten af PhD-projektet.

BILAG

Bilag 1.

Invertebrater på habitatdirektivets bilag 2, 4 eller 5, som findes i Danmark. Ialt 15 arter. Kun hvis status for arten hverken i 2007 eller 2013 er rapporteret ugunstig til EU angives "nej".

Kode	Navn	Videnskabeligt navn	Ugunstig?	Findes hos NST?
1013	Kildevældsvindelsnegl	*Vertigo geyeri*	ugunstig	måske
1014	Skæv vindelsnegl	*Vertigo angustior*	ugunstig	måske
1016	Sumpvindelsnegl	*Vertigo moulinsiana*	nej	ja
1026	Vinbjergsnegl	*Helix pomatia*	nej	ja
1034	Lægeigle	*Hirudo medicinalis*	nej	ja
1037	Grøn kølleguldsmed	*Ophiogomphus cecilia*	ugunstig	ja
1042	Stor kærguldsmed	*Leucorrhinia pectoralis*	ugunstig	ja
1048	Grøn mosaikguldsmed	*Aeshna viridis*	ugunstig	ja
1058	Sortplettet blåfugl	*Maculinea arion*	ugunstig	ja
1065	Hedepletvinge	*Euphydryas aurinia*	ugunstig	ja
1076	Natlyssværmer	*Proserpinus proserpina*	nej	nej
1081	Bred vandkalv	*Dytiscus latissimus*	ugunstig	ja
1082	Lys skivevandkalv	*Graphoderus bilineatus*	ugunstig	ja
1084	Eremit	*Osmoderma eremita*	ugunstig	ja
1936	Stellas mosskorpion	*Anthrenochernes stellae*	nej	ja

Bilag 2.

Padder og krybdyr på habitatdirektivets bilag 2, 4 eller 5, som findes i Danmark. I alt 12 arter. Kun hvis status for arten hverken i 2007 eller 2013 er rapporteret ugunstig til EU angives "nej".

Kode	Navn	Videnskabeligt navn	Ugunstig?	Findes hos NST?
1166	Stor vandsalamander	*Triturus cristatus*	ugunstig	ja
1188	Klokkefrø	*Bombina bombina*	ugunstig	ja
1197	Løgfrø	*Pelobates fuscus*	ugunstig	ja
1201	Grønbroget tudse	*Bufo viridis*	ugunstig	ja
1202	Strandtudse	*Bufo calamita*	ugunstig	ja
1203	Løvfrø	*Hyla arborea*	ugunstig	ja
1209	Springfrø	*Rana dalmatina*	nej	ja
1210	Grøn frø	*Rana esculenta*	ugunstig	ja
1212	Latterfrø	*Rana ridibunda*	ugunstig	ja
1213	Butsnudet frø	*Rana temporaria*	nej	ja
1214	Spidssnudet frø	*Rana arvalis*	ugunstig	ja
1261	Markfirben	*Lacerta agilis*	ugunstig	ja

Bilag 3.

Pattedyr på habitatdirektivets bilag 2, 4 eller 5, som findes i Danmark. I alt 23 arter. Kun hvis status for arten hverken i 2007 eller 2013 er rapporteret ugunstig til EU angives "nej".

Kode	Navn	Videnskabeligt navn	Ugunstig?	Findes hos NST?
1308	Bredøret flagermus	*Barbastella barbastellus*	ugunstig	ja
5009	Dværgflagermus	*Pipistrellus pygmaeus*	ugunstig	ja
1309	Pipistrelflagermus	*Pipistrellus pipistrellus*	nej	ja
1317	Troldflagermus	*Pipistrellus nathusii*	nej	ja
1312	Brunflagermus	*Nyctalus noctula*	nej	ja
1331	Leislers flagermus	*Nyctalus leisleri*	nej	næppe
1330	Skægflagermus	*Myotis mystacinus*	nej	ja
1323	Bechsteins flagermus	*Myotis bechsteinii*	ugunstig	ja
1314	Vandflagermus	*Myotis daubentonii*	nej	ja
1318	Damflagermus	*Myotis dasycneme*	nej	ja
1320	Brandts flagermus	*Myotis brandtii*	nej	ja
1322	Frynseflagermus	*Myotis nattereri*	nej	ja
1327	Sydflagermus	*Eptesicus serotinus*	nej	ja
1313	Nordflagermus	*Eptesicus nilssonii*	nej	næppe
1326	Langøret flagermus	*Plecotus auritus*	nej	ja
1332	Skimmelflagermus	*Vespertilio murinus*	nej	ja
1341	Hasselmus	*Muscardinus avellanarius*	ugunstig	ja
1343	Birkemus	*Sicista betulina*	ugunstig	måske
1355	Odder	*Lutra lutra*	ugunstig	ja
1357	Skovmår	*Martes martes*	nej	ja
1358	Ilder	*Mustela putorius*	nej	ja
1364	Gråsæl	*Halichoerus grypus*	ugunstig	måske
1365	Spættet sæl	*Phoca vitulina*	nej	ja

Bilag 4.

Planter på habitatdirektivets bilag 2, 4 eller 5, som findes i Danmark. I alt 13 arter. Kun hvis status for arten hverken i 2007 eller 2013 er rapporteret ugunstig til EU angives "nej".

Kode	Navn	Videnskabeligt navn	Ugunstig?	Findes hos NST?
1378	Rensdyrlav	*Cladonia spp. (subgenus Cladina)*	ugunstig	ja
1386	Grøn buxbaumia	*Buxbaumia viridis*	ugunstig	ja
1393	Blank seglmos	*Drepanocladus vernicosus*	ugunstig	måske
1400	Almindelig hvidmos	*Leucobryum glaucum*	nej	ja
1409	Tørvemos (alle arter)	*Sphagnum spp.*	ugunstig	ja
1413	Ulvefod (alle arter)	*Lycopodium spp.*	nej	ja
1419	Enkelt månerude	*Botrychium simplex*	ugunstig	nej
1528	Gul stenbræk	*Saxifraga hirculus*	ugunstig	måske
1614	Krybende sumpskærm	*Apium repens*	nej	nej
1762	Guldblomme	*Arnica montana*	nej	ja
1831	Vandranke	*Luronium natans*	ugunstig	ja
1902	Fruesko	*Cypripedium calceolus*	ugunstig	ja
1903	Mygblomst	*Liparis loeselii*	ugunstig	ja

Bilag 5.

Rent akvatiske arter, hvor indsatsen defineres i vand- og natura 2000 planerne. I alt 19 arter fra habitatdirektivets bilag. Hvis status for arten hverken i 2007 eller 2013 er rapporteret ugunstig til EU angives "nej".

Kode	Navn	Videnskabeligt navn	Ugunstig?	Levested
1029	Flodperlemusling	*Margaritifera margaritifera*	ugunstig	ferskvand
1032	Tykskallet Malermusling	*Unio crassus*	ugunstig	ferskvand
1091	Flodkrebs	*Astacus astacus*	nej	ferskvand
1095	Havlampret	*Petromyzon marinus*	ugunstig	ferskvand
1096	Bæklampret	*Lampetra planeri*	nej	ferskvand
1099	Flodlampret	*Lampetra fluviatilis*	nej	ferskvand
1102	Maj-sild	*Alosa alosa*	nej	marin
1103	Stavsild	*Alosa fallax*	nej	marin
1106	Laks	*Salmo salar*	ugunstig	ferskvand
1109	Stalling	*Thymallus thymallus*	ugunstig	ferskvand
1113	Snæbel	*Coregonus oxyrhynchus*	ugunstig	ferskvand
2492	Heltling	*Coregonus albula*	nej	ferskvand
2494	Helt	*Coregonus lavaretus*	nej	ferskvand
1145	Dyndsmerling	*Misgurnus fossilis*	nej	ferskvand
1149	Pigsmerling	*Cobitis taenia*	nej	ferskvand
1351	Marsvin	*Phocoena phocoena*	ugunstig	marin
2032	Hvidnæse	*Lagenorhynchus albirostris*	nej	marin
2618	Vågehval	*Balaenoptera acutorostrata*	nej	marin
1833	Liden najade	*Najas flexilis*	ugunstig	ferskvand

Bilag 6.

Arter af fugle, som i 2013 blev rapporteret *i tilbagegang siden år 2000*, samtidig med at de *på EU-niveau var ugunstige i 2004*. I alt 28 arter. Trend gælder bestandstal. "-" står for tilbagegang og "+" for fremgang. Kilde:

(http://bd.eionet.europa.eu/activities/Reporting/Article_12/Reports_2013/Member_State_Deliveries).

	Trend 1980-2011	Primær biotop	Bilag 1-art?	Bestand (mindst)
Vendehals	-	skov		30
Grønspætte	-	skov		320
Grå Fluesnapper	-	skov		7.000
Løvsanger	-	skov		260.000
Sortterne	-	mose/sø/å	ja	48
Taffeland	-	mose/sø/å		280
Dobbeltbekkasin	-	mose/sø/å		1.300
Sandterne	-	kyst	ja	1
Brushane	-	kyst	ja	43
Engryle (almindelig ryle)	-	kyst	ja	135
Rødben	-	kyst		9.000
Urfugl	-	hede	ja	0
Stor Tornskade	stabile antal	hede		4
Hvid Stork	-	græsland	ja	1
Bynkefugl	-	græsland		2.700
Engpiber	-	græsland		21.000
Digesvale	-	diverse		11.000
Bysvale	+	diverse		38.000
Toplærke	-	agerland		2
Kirkeugle	-	agerland		43
Tårnfalk	+	agerland		1.500
Agerhøne	-	agerland		6.000
Vibe	-	agerland		20.000
Bomlærke	stabile antal	agerland		28.000
Tornirisk	-	agerland		100.000
Stær	-	agerland		270.000
Gulspurv	-	agerland		310.000
Sanglærke	-	agerland		700.000

Bilag 7.

Arter af fugle, som i 2013 blev rapporteret *i tilbagegang siden år 2000*, men som *ikke blev vurderet ugunstige i 2004 på EU-niveau*. I alt 36 arter. Kilde og forkortelser som i bilag 6.

	Trend 1980-2011	Biotop	Bilag 1-art?	Bestand (mindst)
Duehøg	-	skov		270
Spurvehøg	stabile antal	skov		2.100
Halemejse	-	skov		4.700
Gulbug	-	skov		7.500
Broget Fluesnapper	-	skov		8.000
Kærnebider	+	skov		9.500
Dompap	+	skov		15.000
Misteldrossel	stabile antal	skov		15.000
Topmejse	-	skov		15.000
Fuglekonge	-	skov		29.000
Vandstær	+	mose/sø/å		1
Pungmejse	fluktuerende	mose/sø/å		6
Vandrikse	stabile antal	mose/sø/å		1.100
Sivsanger	-	mose/sø/å		2.000
Knopsvane	stabile antal	mose/sø/å		3.600
Grønbenet Rørhøne	-	mose/sø/å		3.600
Blishøne	stabile antal	mose/sø/å		6.800
Rørsanger	-	mose/sø/å		34.000
Karmindompap	fluktuerende	kyst		50
Ride	stabile antal	kyst		340
Fjordterne	-	kyst	ja	420
Klyde	-	kyst	ja	2.400
Havterne	-	kyst	ja	4.500
Strandskade	-	kyst		7.000
Gråsisken	-	hede		6.000
Sortstrubet Bynkefugl	+	græsland		58
Husrødstjert	+	diverse		500
Sjagger	-	diverse		500
Gravand	-	diverse		1.500
Fiskehejre	+	diverse		4.200
Mursejler	-	diverse		15.000
Skarv	+	diverse		25.189
Jernspurv	-	diverse		50.000
Hættemåge	-	diverse		80.000
Gærdesmutte	+	diverse		130.000
Stillits	+	agerland		23.000

Bilag 8.

De globalt truede marine arter med yngleforekomst i Danmark.

Art	Latinsk navn	Global kategori	Dansk rødlistekategori	Forekomst i DK
Skade	*Dipturus batis*	CR	Havfisk ikke bedømt	Marin, ikke NST.
Torsk	*Gadus morhua*	VU	Havfisk ikke bedømt	Marin, ikke NST.
Kuller	*Melanogrammus aeglefinus*	VU	Havfisk ikke bedømt	Marin, ikke NST.
Gråhaj	*Galeorhinus galeus*	VU	Havfisk ikke bedømt	Marin, ikke NST.
Sildehaj	*Lamna nasus*	VU	Havfisk ikke bedømt	Marin, ikke NST.
Pighaj	*Squalus acanthias*	VU	Havfisk ikke bedømt	Marin, ikke NST.

Bilag 9.

De globalt truede arter med gæsteoptræden i Danmark uden ynglen.

Art	Latinsk navn	Global kategori	Dansk rødlistekategori	Forekomst i DK
Ål	*Anguilla anguilla*	CR	CR	Talrig, udbredt, men på retur.
Alm. stør	*Acipenser sturio*	CR	NA, dvs ikke dansk	Marin, ikke forsøgt detaljeret her.
Havengel	*Squatina squatina*	CR	Havfisk er ikke bedømt	Marin, ikke forsøgt detaljeret her.
Helleflynder	*Hippoglossus hippoglossus*	EN	Havfisk er ikke bedømt	Marin, ikke forsøgt detaljeret her.
Atlantisk tun	*Thunnus thynnus*	EN	Havfisk er ikke bedømt	Marin, ikke forsøgt detaljeret her.
Finhval	*Balaenoptera physalus*	EN	Anset for strejfgæst	Marin, ikke forsøgt detaljeret her.
Kaskelot	*Physeter macrocephalus*	VU	Anset for strejfgæst	Marin, ikke forsøgt detaljeret her.
Brugde	*Cetorhinus maximus*	VU	Havfisk er ikke bedømt	Marin, ikke forsøgt detaljeret her.
Hammerhaj	*Sphyrna zygaena*	VU	Havfisk er ikke bedømt	Marin, ikke forsøgt detaljeret her.
Fløjlsand	*Melanitta fusca*	EN	Trækgæster ikke bedømt	Marin, ikke forsøgt detaljeret her.
Havlit	*Clangula hyemalis*	VU	Trækgæster ikke bedømt	Marin, ikke forsøgt detaljeret her.
Dværggås	*Anser erythropus*	VU	Trækgæster ikke bedømt	Gæst, ikke forsøgt detaljeret her.

Bilag 10.

Globalt truede arter som faktisk ikke eller kun tilfældigt optræder i Danmark.

Art	Latinsk navn	Global kategori	Dansk rødlistekategori	Forekomst i DK
Guitarfisk	*Rhinobatos rhinobatos*	EN	Havfisk er ikke bedømt	Marin, ikke forsøgt detaljeret her.
En hybrid birk	*Betula oycoviensis (= B. pendula x szaferi)*	VU	Ikke medtaget	Kunstig hybrid opstået i/ved botaniske haver.
En flodperle-musling	*Margaritifera auricularia*	CR	Muslinger er ikke bedømt	Aldrig registreret i Danmark. Fejlangivet fra Danmark af IUCN.
En art træbuk	*Rosalia alpina*	VU	Ikke medtaget	Kun et tilfældigt indslæbt fund.

Bilag 11.

Ekstra globalt truede arter listet 9/5 2015 – 23/8 2016, og som iflg IUCN optræder i Danmark.

Art	Latinsk navn	Global kategori	Dansk rødlistekategori
Stor ridderhat	*Tricholoma acerbum*	VU	CR
Grøngul vokshat	*Hygrocybe citrinovirens*	VU	EN
Jensens vokshat	*Hygrocybe ingrata*	VU	EN
Taffeland	*Aythya ferina*	VU	LC
Turteldue	*Streptopelia turtur*	VU	NT
Nordisk lappedykker	*Podiceps auritus*	VU	RE
Lunde	*Fratercula arctica*	VU	Trækgæster ikke bedømt
Skolæst	*Coryphaenoides rupestris*	CR	Havfisk ikke bedømt
En art rokke	*Leucoraja fullonica*	VU	Havfisk ikke bedømt
Klumpfisk	*Mola mola*	VU	Havfisk ikke bedømt
Hestemakrel	*Trachurus trachurus*	VU	Havfisk ikke bedømt

CHAPTER 4

Muligheder på Naturstyrelsens arealer for bedre opfyldelse af 2020-mål for truede arter

Erik Buchwald & Jacob Heilmann-Clausen

(February 2018)

Previous page: Cetonia aurata (photo by Erik Buchwald)

UNIVERSITY OF COPENHAGEN
NATURAL HISTORY MUSEUM OF DENMARK
CENTER FOR MACROECOLOGY, EVOLUTION AND CLIMATE

Muligheder på Naturstyrelsens arealer for bedre opfyldelse af 2020-mål for truede arter.

Erik Buchwald

Jacob Heilmann-Clausen

Februar 2018

Titel	**Muligheder på Naturstyrelsens arealer for bedre opfyldelse af 2020-mål for truede arter.**
Kontekst	Rapporten er udarbejdet som led i Erhvervs-PhD-projektet: "Analyse og prioritering af fremtidig indsats for biodiversitet - med særligt henblik på Naturstyrelsens arealer". Projektet løb 2015-18 og havde til formål at undersøge og analysere, hvor og hvordan man i Danmark kan gøre en effektiv indsats for at hindre tab af biodiversitet – særligt på de ca. 2.000 kvadratkilometer af Danmark, som forvaltes af Naturstyrelsen.
Forfattere	Erik Buchwald, Erhvervs-PhD studerende og Jacob Heilmann-Clausen, Lektor, vejleder
Dato	14. februar 2018
Sted	Center for Makroøkologi, Evolution og Klima (CMEC) Statens Naturhistoriske Museum, Københavns Universitet Universitetsparken 15, 2100-København Ø. Rapporten kan downloades: http://macroecology.ku.dk/dk/andre-publikationer/
Layout	Lotte Nymark Busch Jensen (forsidedesign) og Erik Buchwald.
Forsidefoto	Sortspætte, kejserkåbe på kærtidsel, flammeporesvamp og væltet gammel bøg (fotos: Lassi Rautiainen, Erik Buchwald, Jacob Heilmann-Clausen og Erik Buchwald).
Sideantal	67 sider plus bilag.
TAK	Stor tak for tilladelse til brug af data til Dansk Ornitologisk Forening, Lepidopterologisk Forening, Danmarks SvampeAtlas, Dansk Botanisk Forening, Fynske Insekter og Danmarks Edderkopper, Statens Naturhistoriske Museum og Naturstyrelsen, samt til Fugle & Natur (licens B05/2014). De mange frivillige takkes for deres enorme registreringsindsats. Artseksperterne Jan Pedersen, Nikolaj Scharff og Ulrik Søchting ved Statens Naturhistoriske Museum takkes for hjælp til at finde og kvalitetssikre data. Carsten Rahbek, Bjørn Hermansen, Anders Højgaard Petersen, Louis A. Hansen and Lotte Jensen ved CMEC takkes for hjælp og råd i projektet. Tak også til Hugh Possingham og Matthew Watts for at stille Marxan programmerne til rådighed. Danmarks Grundforskningsfond takkes for finansiering til CMEC (DNRF96). Naturstyrelsen og Innovationsfonden (Erhvervs-PhD bevilling nr. 4135-00145B) takkes for finansieringen af PhD-arbejdet.

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1. Indledning

Denne rapport over muligheder for bedre opfyldelse af 2020-mål for truede arter på Naturstyrelsens arealer er udarbejdet som led i Erhvervs-PhD-projektet: "Analyse og prioritering af fremtidig indsats for biodiversitet - med særligt henblik på Naturstyrelsens arealer". Projektet løber 2015-18 og har til formål at undersøge og analysere, hvor og hvordan man i Danmark kan gøre en effektiv indsats for at hindre tab af biodiversitet – særligt i den del af Danmark, som forvaltes af Naturstyrelsen (NST). Rapporten redegør bl.a. for metoderne brugt til at analysere og prioritere mulighederne på Naturstyrelsens arealer, med hensyn til hvor indsats kan hjælpe de truede arter.

I projektets første rapport fra september 2016 "Identifikation af arter og naturtyper i 2020 biodiversitets målene" (Buchwald & Heilmann-Clausen 2016) er de politiske mål i Biodiversitets-Konventionen og afledte regionale og nationale strategier gennemgået. Målene omhandler bl.a. indsats for truede arter, så deres udryddelse forebygges. Truede arter udgøres af arter i kategorierne CR (kritisk truet), EN (moderat truet) og VU (sårbar) i globale eller regionale rødlister. Desuden er kategorien RE (regionalt uddød) relevant, i det omfang sådanne arter dukker op igen.

Projektet har især for Naturstyrelsens arealer analyseret og prioriteret de truede arter og deres konkrete levesteder i forhold til viden om bl.a. arternes økologiske behov og hidtidige udvikling, samt relation til hidtidig drift og beskyttelse. Prioriteringen var på arter, som er af særlig betydning for, at Danmark kan nå det politisk vedtagne 2020-mål om at standse tabet i biodiversitet. De højst prioriterede steder listes i bilag til denne rapport, mens lavere prioriteter fremgår af GIS-database leveret elektronisk til Naturstyrelsen.

Projektets primære resultater er i form af en række GIS- og excel-filer afleveret og gennemgået for Naturstyrelsen primo november 2017, for at resultaterne kunne nå at blive anvendt til Naturstyrelsens arbejde med at foreslå områder til udmøntning af Regeringens Naturpakke.

1.1 Opgave afgrænsning - *2020-måls-arter undtagen de fuldt akvatiske*

Opgaven har fokus på arter, som er truede globalt, nationalt eller på Natura 2000 direktivernes bilag (ynglefugle bilag 1; habitat bilag 2, 4 og 5). Erhvervs-PhD-projektet og dermed denne rapport ser dog kun på de mere eller mindre terrestriske arter og naturtyper. Dvs. fuldt akvatiske arter i hav, sø og å er udeladt. Akvatiske arter, som tidvis er på land (amfibiske arter) medtages, såfremt en eller flere arter i familien er medtaget på habitatdirektivets bilag. Derfor er fx fisk, hvaler, slørvinger og døgnfluer ikke behandlet, mens bl.a. sæler, frøer, salamandre, vandkalve og guldsmede behandles. Samlet set kan man kalde de således afgrænsede arter for *2020-måls-arter*, idet de altså er afledt af de internationale politiske mål for biodiversitet for året 2020.

2. Baggrund

2.1 2020-mål for arter

Danmark har politisk forpligtet sig til at arbejde for at standse tilbagegangen i biodiversitet inden 2020, dels i FN regi, dels i EU regi.

Med hensyn til arter er et af målene i **FN regi** at undgå uddøen af truede arter (dvs. rødliste kategorierne CR kritisk truet, EN moderat truet og VU sårbar) inden 2020 og at forbedre arternes status, især for arter i størst tilbagegang: "By 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained" (Aichi mål 12 besluttet i Nagoya i 2010).

I **EU regi** indeholder biodiversitetsstrategien fra 2011 bl.a. mål om, at der i 2020 skal være 50 % flere arter og fugle omfattet af habitat- og fugledirektivernes rapporteringspligt, som har god eller forbedret status sammenlignet med rapporteringerne fra 2004 for fugle henholdsvis 2007 for andre arter.

Samlet set er det således arter, som er truede globalt, nationalt eller listet på EU-naturdirektivernes bilag, som spiller direkte ind på de politiske 2020-mål for biodiversitet. Det er derfor de arter, der er taget udgangspunkt i i denne rapport, og derfor de omtales som 2020-måls-arter.

2.2 Beskyttelse og drift på Naturstyrelsens arealer

Naturstyrelsen har siden 1989 gennemført en betydelig omstilling af driften af statsskovene, så hensynet til biodiversitet er blevet kraftigt opprioriteret (Rigsrevisionen 2016). Alle arealer er således underlagt en række generelle beskyttelsesbestemmelser og "økologiske retningslinjer" til gavn for dyr, svampe og planter, så der bl.a.

- alle steder skal udvikles og bevares gamle træer ("Livstræer"), som skal stå til højst mulig alder og efterfølgende naturlig død og forfald, foruden generel øgning af mængden af dødt ved,
- generelt arbejdes på at genskabe naturlig hydrologi, i det omfang lovgivning mv tillader det,
- ikke fældes hule træer eller meget gamle træer (bøg > 200 år, eg > 300 år),
- ikke bruges pesticider eller gødskning,
- med naturnær skovdrift arbejdes i retning af blandede bevoksninger med flere aldre og øget brug af hjemmehørende arter.

Statsskovene er også certificeret efter både "Forest Stewardship Council" (FSC) og "Programme for the Endorsement of Forest Certification" (PEFC). Sammen med en række andre retningslinjer og indsatser også på Naturstyrelsens lysåbne biotoper medfører det, at beskyttelsesniveauet for arter på alle styrelsens arealer er hævet betydeligt i forhold til de krav, som stilles til andre ejere. Årsagen til det hævede niveau ligger i Naturstyrelsens formål og i skovlovens særlige bestemmelser om, hvordan statens skove skal forvaltes (Rigsrevisionen 2016).

Ikke desto mindre er der en række arter af dyr, svampe og planter, som har så specifikke krav for at trives, at man ikke kan være sikker på deres langsigtede overlevelse uden yderligere tiltag. Derfor er der især siden 1992 udlagt over 8.000 hektar til urørt skov, græsningsskov og stævningsskov, samt 4.500 ha med plukhugst på Naturstyrelsens arealer (Rigsrevisionen 2016).

2.3 Formål og spørgsmål i Erhvervs-PhD projektet

Projektet "Analyse og prioritering af fremtidig indsats for biodiversitet - med særligt henblik på Naturstyrelsens arealer" 2015-2018 har haft til formål at undersøge og analysere, hvor og hvordan man i Danmark kan gøre en effektiv indsats for at hindre tab af biodiversitet – særligt på de ca. 2.000 kvadratkilometer af Danmark, som ejes af Miljøministeriet v/ Naturstyrelsen.

Det er veldokumenteret forskningsmæssigt, at biodiversiteten med dens mangfoldighed af planter, dyr og andre organismer samt økosystemer både globalt og i Danmark er i tilbagegang, og at mange arter er truet af udryddelse (Ejrnæs et al. 2011, Johanssen et al. 2013, Mace et al. 2008, Petersen et al. 2012, Wind & Ejrnæs 2014). Den hidtidige beskyttelse af natur med høj kvalitet har derfor ikke været tilstrækkelig. I et stærkt udnyttet landskab som det danske spiller forsinket uddøen ("extinction debt") desuden en vigtig rolle, og betinger at der er behov for en udvidelse af det beskyttede naturareal, hvis yderligere tab af arter skal undgås.

Politisk har de fleste af verdens lande, herunder som nævnt Danmark, ved aftaler under Biodiversitets-Konventionen forpligtet sig til at standse tilbagegangen i biodiversitet, herunder med specificerede mål for år 2020 både på EU-niveau og globalt i FN-regi. PhD-projektet fokuserer jf. 2020-målene på de truede arter. Truede arter listes i såkaldte rødlister fordelt på tre kategorier afhængigt af, hvor truede de vurderes at være (Wind & Ejrnæs 2014).

For at kunne hjælpe de truede arter forvaltningsmæssigt, er det nødvendigt at kende deres krav til levested, og hvilke trusler, der er vigtige for dem. Oplysninger herom er af Århus Universitet samlet i en rødliste-database, hvis data dog er heterogene, ufuldstændige og af vekslende faglig kvalitet (Wind & Pihl 2010). Derudover findes en væsentlig detail litteratur om en mindre del af arterne og om metoder til analyse og prioritering (Ejrnæs et al. 2011, Fordham et al. 2013, Geldmann et al. 2013, Jackson & Hobbs 2009, Mascia et al. 2014, Wind & Ejrnæs 2014).

Der er i 2011-2013 udført overordnede analyser af den hidtidige status og indsats for dansk biodiversitet, som bl.a. peger på behov for en tilgang til forvaltning og beskyttelse, som er mere målrettet de truede arter, men også at skovene er af afgørende betydning for en meget stor andel af de truede arter (Ejrnæs et al. 2011, Johanssen et al. 2013).

Hvilke drifts- og naturplejeformer, der anses for mest omkostningseffektive og hensigtsmæssige, er samfunds- og forskningsmæssigt omdiskuteret i disse år, men for de enkelte truede arter og artsgrupper kan der som regel udledes relevante oplysninger om deres økologiske behov (Fowler et al. 2014, Kuuluvainen 2009, Nielsen 2009, Sandom et al. 2014, Stokland et al. 2012).

De Økonomiske Råd har i relation til bevarelse af den danske biodiversitet konkluderet, at en stor indsats i skovene bør prioriteres højt, og at der er brug for mere målrettet indsats i den åbne natur (Petersen et al. 2012). Rådets analyser var i høj grad baseret på data for Danmark opdelt i 10 x 10 km kvadrater. For at gøre det mere målrettet og forvaltningsegnet er der behov for at komme længere ned i skala til konkrete naturarealer, herunder skove.

Erhvervs-PhD-projektet har derfor for Naturstyrelsens arealer gået dybere end de ovennævnte overordnede analyser og vurderinger ved at analysere og prioritere de truede arter og deres konkrete levesteder i forhold til viden om arternes økologiske behov, udbredelse, relation til driftsformer, samt hidtidige udvikling i Danmark. Fokus er på arter, som ser ud til at være af særlig betydning for, om Danmark kan nå det politisk vedtagne 2020-mål om at standse tabet i biodiversitet.

2.4 Regeringens Naturpakke 2016

Ca. et år efter PhD-projektets start lancerede Regeringen d. 20. maj 2016 "Aftale om Naturpakke", som bl.a. fastslog at "aftaleparterne prioriterer at standse tilbagegangen i biodiversitet", at der på Naturstyrelsens arealer skulle udlægges "i alt 13.300 nye ha skov til biodiversitetsformål", og at en "stor effekt i forhold til at fremme forholdene for en lang række truede arter" var en del af formålet.

Udlægningen skulle ske på den mest omkostningseffektive måde og ved inddragelse af nyeste viden samt konsultation af relevante forskningsmiljøer. De 13.300 ha skulle fordeles med

- 6.700 ha urørt skov i løvskove
- 3.300 ha urørt skov i nåletræsplantager
- 3.300 ha anden biodiversitetsskov, primært i løvskove

Løvskove og *nåletræsplantager* henviser til om skoven ligger i eller udenfor de gamle skovegne i det østlige Danmark.

I lyset af Naturpakken blev PhD-projektets fokus justeret, så det kunne bidrage bedst muligt til en videnbaseret og omkostningseffektiv udpegning af relevante skovarealer. Skovlevende arter fik derfor endnu større fokus i projektet.

2.5 Arternes økologiske behov

For at kunne beskytte 2020-måls-arterne så godt som muligt har PhD-projektet gennemgået alle arterne for at identificere deres overordnede økologiske behov. Behovene er derpå sat i relation til Naturpakkens arealkategorier og forsøgt vurderet i forhold til, hvad arterne behøver oveni Naturstyrelsens normale generelle beskyttelsesniveau.

Generelt er arter evolutionært udviklet igennem så mange årtusinder til årmillioner, at deres økologiske behov og andre tilpasninger vil være sket i landskaber med ingen eller meget lille indflydelse fra mennesker.

I princippet kan alle arter derfor klare sig i et landskab uden påvirkning fra mennesker, og man kunne forestille sig, at alle de truede skovarter, der har overlevet i Danmark, kan trives i skov, som man udlægger urørt. Der er dog en række årsager til, at dette ikke altid er tilfældet:

1. Arter der findes i det nordvestlige Europa, herunder Danmark, er oprindelig udviklet i ufragmenterede naturlige landskaber med mange store græssende dyr, som væsentligt påvirkede landskab og vegetation (Andersson et al. 1990, Dirzo 2014, Nielsen 2009, Owen-Smith 1992, Vera 2000), hvilket afviger stærkt fra nutidens forhold.
2. Danmarks og andre nordvesteuropæiske skovlandskaber har dramatisk ændret karakter gennem de sidste 200 år fra en overudnyttet unaturligt næringsfattig tilstand med relativt åbne græsningsskove (Odgaard 1994, Timmermann et al. 2015, Tybirk et al. 1999, Vandekerkhove 2012, Vaupell 1863) til en luftforureningsbetinget unaturligt nærings- og CO_2-beriget tilstand, som regel uden græsning. Det fører til unaturligt høj, tæt og frodig vegetation (Kahle 2008, Timmermann et al. 2015, Tybirk et al. 1999).
3. De danske skove er ensartede og unge som følge af den hidtidige dyrkning med dominans af ensaldrende bevoksninger med kun én træart og en del ikke-hjemmehørende træarter (Feilberg 2004, Nord-Larsen et al. 2016). Udlæg af sådanne skove til urørt skov vil ikke medføre urskovsagtige tilstande før efter flere hundrede år. Navnlig er der risiko for en lang periode med tætte og mørke bevoksningsstrukturer og dermed tab af lys- og varmekrævende arter.
4. Nogle arter har deres klimatiske udbredelsesgrænse i Danmark og risikerer alene som følge af klimaændringer at forsvinde. (Huntley et al. 2007, Settele et al. 2008, Skov et al. 2006, Svenning et al. 2008, Virkkala 2013).
5. En række andre trusler fra fx isolation/fragmentering, invasive arter og forsinket uddøen kan betyde et tab af isolerede bestande af truede arter, hvis der ikke sættes ind med aktive målrettede plejetiltag (Geldmann et al. 2014, Joppa 2016, Timmermann et al. 2015, Wind & Pihl 2010).

Mange arter er dermed blevet rødlistet som truede på grund af tilbagegang i de tidligere næringsfattige åbne biotoper eller som følge af, at deres levesteder, fx gamle solbeskinnede egetræer, er blevet overskygget af høj skyggende tilgroning (Timmermann et al. 2015, Wind & Pihl 2010).

Det er ikke givet, at de arter, som er defineret som "skovarter", reelt er så bundet til skov, at de kan trives i moderne urørt skov. Definitionen af skovarter er nemlig bred og inkluderer arter primært knyttet til lysåbne biotoper, men også tilstede i skovlysninger, fx en række dagsommerfugle (Petersen et al. 2016b).

Der er forskellige bud på, hvordan naturforvaltningen overordnet kan gribes an for at håndtere disse problemstillinger. Traditionelt har meget naturforvaltning taget udgangspunkt i et statisk eller historisk begrundet natursyn, hvor målet er at bevare nuværende værdier, typisk med stærkt fokus på hjemmehørende arter og historiske naturtyper, inklusiv dem, som er blevet fremmet i et historisk kulturlandskab (fx hø-enge, stævningsskov mv.). Dette natursyn gennemsyrer megen lovgivning på området, og anes tydeligt i fx habitatdirektivets fokus på at fastholde bestemte veldefinerede naturtyper, mens tab af truede arter ses som en forvaltningsmæssig fiasko.

I modsætning hertil står et dynamisk natursyn, som anerkender, at naturen er under konstant forandring som konsekvens af naturlige (fx forsinket spredning af arter efter istiden) og menneskeskabte processer (fx klimaændringer, eutrofiering, flytning af arter), og at det derfor ofte er både dyrt og uhensigtsmæssigt at arbejde for at forvalte naturen statisk. I stedet sætter den dynamiske naturforvaltning fokus på behovet for plads til naturen og eventuelt for genopretning af de naturlige processer, som mennesket har afbrudt, men som har haft afgørende betydning for arternes evolution og indbyrdes konkurrence over mange årtusinder. I dette perspektiv bliver de enkelte arter i højere grad set som indikatorer for de aktuelle biologiske processer, end som mål i sig selv, og nyindvandrede arter vil indgå på lige fod med hjemmehørende arter i evalueringen af succes i naturforvaltningsprojekter.

I nærværende arbejde har vi valgt en pragmatisk tilgang til problemstillingen, men med udgangspunkt i naturens uomtvisteligt dynamiske karakter og med respekt for at der er et stærkt artsfokus i de politiske 2020-mål for biodiversitet. Med dette udgangspunkt kan vi konstatere, at alle truede skovarter i Danmark på kort sigt med stor sandsynlighed ikke kan få deres økologiske behov opfyldt i urørt skov, og at der derfor er behov også for mere aktive tiltag som en slags nødløsning for lokalt at forsøge at kompensere for de overordnede negative menneskeskabte forandringer, som skader arternes muligheder for overlevelse.

Urørt skov er ifølge den videnskabelige litteratur et af de vigtigste redskaber til at gavne mange skovarter, men bevaring af arterne kan også kræve behov for aktiv indsats (fx Bernes et al. 2015, Boch et al. 2013, Brunet et al. 2010, Flensted et al. 2016, Lindenmayer & Franklin 2002, Lindhe et al. 2005, Lundström et al. 2016, Peterken 1996, Vera 2000)

Afgrænsningen mellem skovarter og ikke-skovarter er i denne sammenhæng central. Mange arter trives nemlig bedst i gradvise overgange mellem forskellige biotoper, "ecotones" (Risser et al. 1995), fx mellem åbent land og skov som er naturlige på vores breddegrader, både som følge af gradienter mod kyst, mose og særligt næringsfattig jordbund, og som konsekvens af naturlige forstyrrelser fra stormfald, ild og græsning. Den slags overgange er blevet unaturligt sjældne i det moderne landskab - i høj grad en konsekvens af fredskovsforordningen fra 1805, som skarpt og kunstigt opdelte Danmark i skov og ikke-skov, hvor skov havde fokus på tømmerproduktion, mens skovgræsning blev ulovliggjort. Den danske naturforvaltning og terminologi har haft og har stadig svært ved at komme ud over denne unaturlige og skarpe opdeling mellem skov og ikke-skov. Det har desværre også i nærværende projekt vist sig umuligt at undgå en sådan opdeling.

Derudover er der et skisma i forhold til truede arter knyttet til ikke-hjemmehørende arter, samt hvordan disse arters økologiske behov håndteres. Det er fx ikke entydigt, om rødgran må anses for hjemmehørende i Danmark og dermed om arter afhængige af rødgran anses for hjemmehørende (Buchwald et al. 2013, Feilberg 2004, Hartvig 2015, Skipper 2017). I denne sammenhæng har vi for at sikre konsistens til den danske rødliste (Wind & Pihl 2010) valgt en biogeografisk i stedet for lande-politisk tilgang, således at truede arter hjemmehørende i en af de to biogeografiske regioner, som Danmark tilhører (den Atlantiske og den Kontinentale) medtages, uanset om de anses for hjemmehørende i Danmark eller ej.

Problemstillingen er særlig relevant i forhold til arter med behov for nåletræer eller nåleskov. Nåleskovene er hovedsagelig plantede bestande og ofte med fremmede træarter fra andre kontinenter (Feilberg 2004, Nord-Larsen et al. 2016). Skovfyr er eneste hjemmehørende træart (Feilberg 2004), hvis man ser bort fra rødgranen og de mere buskagtige ene og taks. Der eksisterede ingen nåleskov i Danmark i lang tid frem til introduktionen af rødgran til skovbruget omkring 1763, fordi de sidste naturlige individer af skovfyr blev fældet og dermed udryddet nogen tid før år 1750. Skove af skovfyr forsvandt endnu tidligere (Feilberg 2004). Udviklingen har siden 1800-tallet gået stærkt den anden vej, og skovfyr dækker nu ca. 5 % af det danske skovareal og rødgran omkring 50 % (Nord-Larsen et al. 2016). Obligate nåleskovsarter må derfor have været forsvundet helt eller delvis omkring år 1750, men en del arter er sidenhen genindvandret eller har bredt sig, hvilket bl.a. er veldokumenteret for fugle (Dinesen et al. 2016).

Den manglende skovtypekontinuitet og en ofte intensiv drift betyder dog, at de danske nåleskove rent biodiversitetsmæssigt er en fattig afglans af de naturlige nåleskove, der kan ses i vores nabolande (Feilberg 2004). Nåleskovenes truede arter er ofte tilknyttet lysningerne eller åben fyrreskov og pionersamfund på meget næringsfattig sandbund (Flensted et al. 2016, Petersen et al. 2018). Nåleskov er blevet prioriteret relativt højt i den hidtidige skovindsats. 28 % af de hidtidigt udlagte urørte skove er således nåleskov (Johannsen et al. 2013) og i regeringens naturpakke er 33 % af det planlagte urørte skovareal henlagt til nåleskovegnene.

De økologiske behov for både skovarter og andre arter kan bruges til at målrette naturforvaltningsindsatsen og udvikle arternes levesteder til en tilstand, som matcher, samtidig med at begrænse kendte trusler i det omfang, det er muligt. Klimaforandringer er et eksempel på en for nogle arter afgørende trussel, som ikke kan begrænses lokalt. Hvis biotop og andre økologiske behov optimeres vil arternes overlevelsesmuligheder øges – måske tilstrækkeligt til at kunne klare også klimapres.

Nogle truede arter kan ud over i beskyttede områder få deres økologiske behov opfyldt helt eller delvist i den ubeskyttede eller generelt beskyttede "matrix", hvilket understøtter opretholdelse af arterne (Brunet et al. 2010, Wilson et al. 2010). Det gælder ikke mindst for arter, der ikke primært er truet af skovdrift, men af andre faktorer, fx klimaændringer eller eutrofiering, men kvaliteten af matrix som levested spiller naturligvis også en afgørende rolle. Som ovenfor nævnt er den generelle naturbeskyttelse på Naturstyrelsens arealer øget væsentligt de sidste ca. 25 år med mere dødt ved, livstræer, naturpleje, forbedret hydrologi mv for at forbedre mulighederne for, at flere truede arter kan få deres økologiske behov opfyldt også i "matrix", dvs. overalt i statsskovene.

Metodikken for fastlæggelse af arternes økologiske behov beskrives nærmere i afsnit 4.

2.6 Optimering af omkostningseffektivitet og forvaltning

Ud over ovenstående biologiske argumenter for valget af indsats kan det tænkes, at nogle skovarters økologiske behov kan tilgodeses med *billigere* tiltag end fx urørt skov, jf. Naturpakkens beslutning om at en del skove skal udlægges som anden biodiversitetsskov, hvor der fortsat kan ske en vis (nedsat) økonomisk udnyttelse. Det kan fx gælde skovarter med præference for halvåbne eller lysåbne biotoper.

I lyset af Naturpakkens beslutning har projektet inddraget økonomien for skovarterne for at optimere omkostningseffektiviteten. Økonomien for ikke-skovarter er derimod kun belyst oversigtligt.

Forskning om biodiversitet i skov anbefaler til supplement af urørt skov en vifte af forvaltningstiltag inklusive genopretning af naturlige processer, videreførelse af gamle driftsformer som græsnings- og stævningsskov, ikke-traditionel aktiv naturforvaltning for at fremme dødt ved og andre urskovsagtige strukturer, samt målrettet artsforvaltning. Derudover beskrives det som vigtigt med et vist minimum af beskyttelse også i det generelle skovlandskab (fx Götmark 2013, Timmermann et al. 2015, Watson et al. 2016). Valget af konkrete tiltag kan begrundes ud fra normative principper (fx et statisk eller dynamisk natursyn), faktisk evidens samt økonomiske overvejelser. En række af de nævnte indsatser vil være billigere end udlæg som urørt skov, men nogle af dem kan alt efter omstændigheder også være dyrere.

I denne sammenhæng har vi som nævnt taget udgangspunkt i et pragmatisk dynamisk natursyn, hvor vi anerkender at aktiv forvaltning i en del tilfælde vil være mere effektivt end urørt skov i en længere årrække. Det gælder ikke mindst for arter, som er afhængige af specifikke successionsstadier, som grundet lille naturareal i det moderne landskab ikke kan opretholdes i urørt skov indenfor de tidshorisonter, som er nødvendige for arten (Bernes et al. 2015, Götmark 2013, Vera 2000). En del af de nødvendige tiltag kan indarbejdes i Naturpakkens relativt rummelige forståelse af urørt skov, mens andre med tiden kan erstattes af naturlige dynamikker i større beskyttede landskaber, hvor der er genoprettet dynamikker, som skaber en naturlig balance mellem lysåben natur og skov. Her er der endnu begrænset praktisk evidens i det mindste fra vores breddegrader (Fløjgaard et al. 2017).

I princippet bør et alternativ til urørt skov vælges, hvis det er enten billigere med samme effekt eller beskytter arten bedre. Tilsvarende gælder det, at det alt andet lige er mest omkostningseffektivt at udlægge urørt skov og anden biodiversitetsskov på arealer med lavest økonomisk værdi, såfremt beskyttelseseffekten ikke kompromitteres.

For at nå frem til en omkostningseffektiv udlægning af skove er der derfor behov for at kunne identificere, hvor truede arter, som primært kan gavnes med urørt skov findes, i forhold til hvor der er arter, som kan trives med, eller ligefrem behøve andre beskyttelsesindsatser. Derudover er der behov for viden om den økonomiske værdi af skovproduktion på skovarealerne.

2.7 Systematic conservation planning - SCP

Forskningen anbefaler at bruge optimerings algoritmer (som en del af en ”systematic conservation planning” - SCP) til at kombinere biologiske og økonomiske oplysninger for at opnå omkostningseffektiv beskyttelse af biodiversitet (Margules & Pressey 2000, Moilanen et al. 2009, Venter et al. 2014, 2017, Watson et al. 2016). SCP-algoritmer er blevet udviklet i løbet af de seneste årtier, så de nu er i stand til at levere god vejledning til beslutninger om, hvor og hvordan man effektivt kan nå givne bevaringsmålsætninger, givet at de nødvendige data er tilgængelige (Beyer et al. 2016, Kukkala & Moilanen 2013, Moilanen et al. 2009).

Der er publiceret mange SCP-studier (Kukkala & Moilanan 2013), men kun en meget lille andel af dem har været anvendt i reel naturbeskyttelse (Knight et al. 2008). En hovedårsag til kløften mellem studier og reel implementering er, at virkeligheden er meget kompleks i forhold til de teoretiske modelstudier og derudover karakteriseres af mange begrænsninger af politisk og socioøkonomisk art. En anden medvirkende årsag kan være, at mange SCP-studier kun skelner mellem "beskyttet" og "ubeskyttet" natur i planlægnings-algoritmerne, hvilket oftest er for simpelt, ud over at det groft kan overestimere de økonomiske omkostninger ved naturbeskyttelsen (Watts et al. 2009, Wilson et al. 2010). Hvis man gik ud fra, at kun fuldt naturbeskyttede områder bidrager til arternes beskyttelse, fandt Wilson et al. (2010) fx, at de økonomiske omkostninger blev overvurderet med en faktor 15 og arealet med behov for naturbeskyttelse med en faktor på næsten 50.

Overordnet er det svært at svare på, hvor meget beskyttelse, der skal til for at sikre arternes langsigtede opretholdelse (Tear et al. 2005). Selv for de bedst kendte enkeltarter er det svært at beregne behovet, men det kan tilnærmes ved brug af "population viability analyse - PVA". Metoden kræver dog meget omfattende og detaljeret viden om arten og dens bestande, reproduktion, metapopulationsstruktur mv., som det normalt er umuligt at skaffe uden meget stor forskningsindsats. Med mange arter i spil er det i praksis umuligt at bruge PVA-metoden. I stedet bruges ofte et mere arbitrært fastsat mål i form af, at hver art ønskes beskyttet mindst 1 sted, eller evt. flere steder. Alt andet lige forventes sandsynligheden for langsigtet opretholdelse af en art at stige med antallet af forekomststeder og bestande.

I PhD-projektet blev tilgængelige SCP-metoder og software-systemer screenet og *Marxan with Zones* (MxZ) (Watts et al. 2009) valgt til optimeringsopgaven. Valget skyldtes Marxan-programmets 1) gode dokumentation, 2) udbredte anvendelse, 3) evne til at arbejde effektivt med flere forskellige beskyttelsestyper samtidig (zoner), 4) evne til at løse optimeringsopgaven selv med mange hundrede arter forekommende i mange hundrede forskellige skove, og 5) mulighed for let samspil med GIS for at understøtte en iterativ interaktiv planlægningsproces (Segan et al. 2011, Watts et al. 2008a, Wilson et al. 2010).

Måltallet for antal repræsentationer blev sat til henholdsvis 3 og 5 for at øge sandsynligheden for arternes levedygtighed i forhold til 1 repræsentation og for at kunne vurdere analysernes følsomhed for denne parameter.

3. Data

3.1 Areal- og økonomidata

Data for arealer og økonomi (status 2016) blev leveret af Naturstyrelsen. Det samlede areal forvaltet af styrelsen var 202.402 ha (4,7 % af Danmarks landareal) fordelt på 976 administrative polygoner varierende i størrelse fra mindre end 0,1 ha og op til 6.399 ha. Arealerne omfattede ud over skov også bl.a. søer, heder, veje og andet. Skovbevoksning udgjorde 105.919 ha (52,3 %), heraf 41 % løvtræ- og 59 % nåletræ-domineret.

For hver administrativ polygon leverede Naturstyrelsen økonomiske data i form af årlig potentiel nettoindkomst fra høst af henholdsvis løvtræ og nåletræ, med bemærkning om at tallene var baseret på modelberegninger med pris- og omkostnings-niveau for året 2016. De absolutte værdier svarer derfor ikke nødvendigvis til virkeligheden i hver enkelt skov eller år, men overordnet set skulle tallene være egnede til sammenligning af værdier og til at estimere årligt nettotab i indkomst, hvis en skov udgår af forstlig drift og overgår til urørt skov.

For 18 polygoner med negativ nettoindkomst blev tallet trunkeret til nul, idet de negative værdier var små og næppe realistisk ville blive gennemført i praksis. Andre 327 polygoner havde nettoindkomst på nul i forvejen, fordi de enten var totalt beskyttede skove eller andre biotoper uden relevant forstlig produktion. Det var fx søer forvaltet af Naturstyrelsen med træer langs bredderne.

3.2 Artsoplysninger og -forekomster

Identifikationen af 2020-måls-arterne fremgår mere detaljeret af Buchwald & Heilmann-Clausen (2016), og omfatter de truede arter, som er afgørende for om de politiske 2020 mål for biodiversitet kan nås. I alt drejer det sig i Danmark om potentielt 1932 arter, når man inkluderer alle arter, som er listet på mindst én af de artslister, som 2020 målene omhandler. Taksonomi og navngivning blev strømlinet med standard artslisten "allearter.dk" (DANBIF 2016).

For hver art har projektet sammenstillet oplysninger om bl.a. forekomster, taksonomi, synonymer, levested, trusselskategori og status rapporteret til EU, med henblik på at kunne vurdere hver arts status og behov på lands- og på lokalitetsniveau. Forekomster blev sammenstillet på grundlag af datakilderne listet i bilag A. Funddata blev kvalitetssikret som supplement af dataleverandørernes egen kvalitetssikring gennem en række semi-automatiske procedurer. Derved blev en række fund udeladt som følge af usikkerhed i relation til enten artsidentifikation eller lokalitet. Øvrige oplysninger blev hentet i DCEs rødlistedatabase (Wind & Pihl 2010), i databasen allearter.dk (Skipper 2017), CMECs interne databaser, officielle EU-rapporteringer (EIONET 2013a, EIONET 2013b), DCE rapporter (Fredshavn et al. 2014, Søgaard & Asferg 2007), suppleret med mere specifikke datakilder for de enkelte artsgrupper.

Arternes forekomststeder blev samkørt i GIS med Naturstyrelsens arealer (GIS-fil af 14. april 2016 fra Naturstyrelsen) samt med Danmarks forskellige typer af naturbeskyttelse, herunder Natura 2000 områder, fredninger, § 3 områder, reservater, driftplanbeskyttelse i statsskov, aftaler om skovbeskyttelse osv.. Beskyttelsestyperne blev henført til IUCNs internationale kategorier I til VI, hvor kategori I er den stærkeste beskyttelse (Dudley 2008).

3.3 Prioritering af arter fra 1 til 5, henholdsvis A og B

For at tage højde for fokus i Aichi mål 12 på truede arter *i tilbagegang*, og for den af Wilson et al. (2010) anførte betydning af matrix for mange arter, blev der i projektet skelnet mellem arter med og uden påvist tilbagegang. Arter uden påvist tilbagegang må antages langt hen ad vejen at få deres økologiske behov opfyldt ved det nuværende beskyttelsesniveau, således at deres behov for yderligere beskyttelse alt andet lige er mindre end for arter i tilbagegang.

På baggrund af de indsamlede data om trusselsgrad og bestandsudvikling blev hver art således tildelt en prioritet fra 1 til 5 i forhold til de politiske 2020-mål om at standse tabet af biodiversitet (Buchwald & Heilmann-Clausen 2016):

1) Truet globalt ifølge IUCNs redlist (IUCN 2015).

2) EU art rapporteret ugunstig i 2013 (EIONET 2013a, 2013b)

3) Andre truede arter i tilbagegang jf. Rødliste 2010, inklusive regionalt uddøde (Wind & Pihl 2010).

4) Truede arter uden rapporteret tilbagegang i hverken EU rapporter eller Rødliste 2010.

5) Arter, som ikke matcher prioritet 1 til 4 og kun er listet på slægtsniveau på habitatdirektivet.

Prioritet 1 til 3 er vigtige i relation til FN-målet, mens prioritet 2 er vigtigst for det heraf afledte EU-mål. Såfremt arterne i prioritet 4 og 5 ikke skifter til at være i tilbagegang, påvirker de ikke 2020 målet. Prioritet 1 til 3 blev i visse analyser samlet til A-prioritet, mens prioritet 4 og 5 blev samlet til B-prioritet.

3.4 Habitatpræferencer og trusler

Præferencer, trusler og økologiske behov for hver art blev i første omgang baseret på oplysninger i Rødliste 2010 databasen (Wind & Pihl 2010), som har indsamlet relevante data og erfaringer fra detail litteratur og artseksperter. For nogle få arter, hvor oplysningerne manglede eller var åbenlyst utilstrækkelige, blev supplerende artsspecifik litteratur konsulteret.

Arterne opdeltes først i obligate henholdsvis fakultative skovarter samt ikke-skovarter, med underopdeling af skovarterne til løvskov, nåleskov og løv-nål blandet skov. Opdelingen skete ved hjælp af en tidligere anvendt og kvalitetssikret database hos CMEC (Petersen et al. 2012, Petersen et al. 2016b). For arter, som ikke var med i databasen, er der efter samme metode taget udgangspunkt i oplysningerne om levested i Rødliste 2010 databasen (Wind & Pihl 2010), således at arter med kun skov anført som levested er henført til obligate skovarter, arter med både skov og lysåbne biotoper som levested er henført til fakultative skovarter, og arter uden skov nævnt som levested er henført til ikke-skovarter. Skovarter er således opfattet bredt og inkluderer en række arter, hvis primære biotoper er lysåbne. Der er desuden en glidende overgang mellem skovarter og ikke-skovarter, idet en række arter, som tidligere omtalt, trives bedst i overgangs- eller blandingszoner mellem skov og lysåbne biotoper.

Arter blev endvidere noteret som saproxyliske (medvirkende til, eller afhængige af nedbrydning af dødt ved), hvis de var anført som fakultativt eller obligat saproxyliske i en af de tilgængelige lister over saproxyliske arter relevante for Danmark (Alexander 2002, Köhler 2000, Nieto & Alexander 2010, Stokland & Meyke 2008, Wind & Pihl 2010). Derudover blev deres afhængighed af lysåbne miljøer vurderet, ligesom tilknytning til henholdsvis løv- og nåletræer blev noteret.

De resulterende trusler og økologiske behov blev derefter gennemgået og kvalitetssikret af forfatterne for de artsgrupper, som de havde stor ekspertise i (svampe: Jacob Heilmann-Clausen. Planter, sommerfugle, guldsmede og vertebrater: Erik Buchwald). For tilsvarende at få kvalitetssikret oplysningerne for skovarter i andre artsgrupper blev yderligere artseksperter konsulteret, og det lykkedes at få bidrag fra følgende eksperter ved Statens Naturhistoriske Museum og Biologisk Institut: Jan Pedersen (Biller) og Ulrik Søchting (Laver).

Kvalitetssikringen af arternes trusler og økologiske behov medførte præciseringer for 111 af de 1378 arter (8 %), men der blev ikke fundet fejl. Det vurderes derfor ikke problematisk, at det for knap 8 % af arterne (spindlere, årevinger, tæger, græshopper og fluer) ikke lykkedes at få eksterne artseksperter ind over.

Baseret på ovenstående blev samtlige skovarter til sidst inddelt i grupper med forskellige forvaltningsbehov ud fra deres tilknytning til a) dødt ved (saproxyliske arter), b) lysåben eller skygget habitat (lys behov), c) nåletræer versus løvtræer, samt d) længe urørt skov (Se næste afsnit).

4. Metode

Som følge af Naturpakkens konkrete beslutning om udlæg af store skovarealer til biodiversitetsskov, blev skovarter underkastet andre og mere omfattende analyser end de arter, som ikke er tilknyttet skov. De følgende tre underafsnit omhandler derfor skovarterne, mens øvrige arter omtales i afsnit 4.4 derefter.

4.1 Zoner og beskyttelsestyper for skovarter

For at kunne beregne og omkostningsoptimere beskyttelsen af skovarterne blev forskellige forvaltningsindsatser samlet i fire kategorier, baseret på de enkelte arters præferencer og økologiske behov, og samtidig relateret til Naturpakkens kategorier og til forvaltningsindsatsernes omkostningsniveau.

Efter denne forenkling af kategorier af beskyttelse eller forvaltning til fire "zoner", blev zonerne brugt i optimeringsprogrammet *Marxan with Zones* (Watts et al. 2009), som er specielt udviklet til optimering af valg af områder til naturbeskyttelse.

Zone 1 har som default en speciel betydning ved at være tilgængelig for normal drift, og udgør derved den "ubeskyttede" matrix med omkostning 0. De tre øvrige zoner blev valgt og afgrænset, så de så vidt muligt også kan relateres til internationale forsknings- og erfaringsbaserede skovbeskyttelsestyper (Boch et al. 2013, Buchwald 2005, Götmark 2013, Peterken 1996):

Zone 1 Normal statsskov uden ekstra beskyttelse,
Zone 2 Ekstra beskyttelse af arter knyttet til nåletræer/nåleskov,
Zone 3 Aktiv ekstra beskyttelse af løvskov inkl. gamle driftsformer, og
Zone 4 Urørt løvskov.

Zone 1 indebærer ingen ekstra beskyttelse ud over den generelle beskyttelse, som jf. afsnit 2.2 gælder for alle statsskove. Zone 4 svarer til Naturpakkens urørte skov i løvskovsegne, hvor forstlig økonomisk drift efter en overgangsperiode skal ophøre, mens pleje kan ske i mindre omfang, fx i form af græsning.

Zone 2 og 3 blev afgrænset til at skulle svare til beskyttelse målrettet arter med andre eller mere specifikke økologiske behov end, hvad der normalt kan forventes tilgodeset ved normal drift eller umiddelbar overgang til urørt skov, særligt behov for blomsterrige lysninger, overgangsnaturtyper mellem skov og åbent land eller for specifikke værtstræer som fyr eller eg, der i nordvest Europa ofte bukker under i løbet af en årrække, hvis de overlades til fri konkurrence i urørt skov uden græsning (Götmark 2013, Lindhe et al. 2005, Skov- og Naturstyrelsen 1994, Vera 2000).

Zone 2 og 3 vil delvis svare til Naturpakkens "Anden biodiversitetsskov", men også til en vifte af andre typer beskyttelse, fx græsningsskov, stævningsskov og andre typer mere aktiv skovbeskyttelse i statsskovene, samt med dele af styrelsens beskyttede lysåbne biotoper, hvor der også ofte er træer og buske.

Bemærk, at arter henført til zone 3 (Aktiv) inkluderer arter med helt lysåbne biotoper som primært levested, fx græsland eller hede, hvis et skovlevested er nævnt i rødlistedatabasen i form af skovbryn, skoveng eller skovlysning, selvom skovlevestedet kan være helt marginalt for arten. Det gælder fx sommerfuglen lille køllesværmer (*Zygaena viciae*), blomsterne kostnellike (*Dianthus armeria*) og kvast-høgeurt (*Pilosella cymosa*), samt billen klint-oldenborre (*Omaloplia nigromarginata*).

Mange af de bedste lokaliteter for zone 3 (Aktiv) arter er således lysåbne biotoper omgivet af skov eller med spredte træer, så der er et varmt mikroklima i læ. Det vil åbenlyst være ødelæggende for disse arter, hvis de lysåbne dele, som arterne fordrer, gror helt til med træer. Eksempler er solelskende insekter som svirrefluer, visse biller og de fleste dagsommerfugle, som både har behov for rige nektarkilder fra blomster og solbeskinnede skovbryn eller veteran træer. Tab af lysåbne biotoper som følge af tilgroning med træer anses for en væsentlig trussel for disse arter (Wind & Pihl 2010).

Det følger heraf, at forvaltningen af zone 3 (Aktiv) ikke nødvendigvis bør have fokus på skovbeskyttelse i traditionel forstand. Den skal, afhængigt af artsindholdet have fokus på opretholdelse af de relevante lysåbne biotoper i samspil med omgivende skov eller gamle træer som, igen afhængigt af artsindholdet, i nogle tilfælde kan kombineres med en større eller mindre ved- eller biomasseproduktion, evt. som del af en aktiv habitatpleje. Det medvirker til, at zone 3 kan have relativt lavere omkostninger end zone 4 (Urørt).

Da det bortset fra zone 1 og 4 er vanskeligt mere præcist at estimere de økonomiske konsekvenser / tab, blev optimeringsprogrammet kørt med flere forskellige forudsætninger for omkostninger i zone 2 og 3 (Tabel 1).

Tabel 1. De fire valgte zoner med de undersøgte værdier for økonomisk tab.

Zone	Kort navn	Beskrivelse	Tab
1	Normal	Ingen ekstra beskyttelse (Marxans "available" zone)	0
2	Nål	Skov med ekstra beskyttelse af arter tilknyttet nåletræer	10 eller 25 %
3	Aktiv	Aktiv ekstra beskyttelse i løvskov	50, 75 eller 100 %
4	Urørt	Urørt løvskov	100 %

Skovarter blev ud fra deres økologiske behov og artspræferencer som udgangspunkt fordelt til otte grupper (Tabel 2) som kunne relateres til en eller to af de fire Marxan zoner. Arter med snævre præferencer blev relateret til én zone, mens arter med mindre snævre krav til levested blev relateret til to zoner, hvis begge zoner vil kunne tilgodese arternes behov.

Tabel 2. Karakteristika for artsgrupper brugt til zone fordeling. Hver art blev henført til den første gruppe fra oven som matchede. Arter med fakultativ eller obligat præference for nåletræ blev udelukket fra gruppe 1 til 5.

Gruppe	N	Gruppenavn	Zone(r)	Habitat præferencer / behov / tilknytning
1	38	Lysåben saproxylisk	3+4	Saproxyliske arter tilknyttet løvtræer i lysåbne biotoper, men også i skov.
2	174	Lysåben skov	3	Ikke-saproxyliske arter tilknyttet lysåbne biotoper, men også løvskov.
3	102	Saproxylisk skovart	4	Saproxyliske arter kun tilknyttet løvskov og ikke nogen lysåbne biotoper.
4	55	Urørt løvskov	4	Ikke-saproxyliske arter tilknyttet urørt løvskov, men ikke tilknyttet nogen lysåbne biotoper.
5	147	Anden løvskov	3+4	Ikke-saproxyliske arter tilknyttet løvskov, men hverken tilknyttet urørt skov eller lysåbne biotoper.
6	16	Saproxylisk nåletræsart	2+4	Saproxyliske arter med præference for nåletræ.
7	55	Obligat nåletræsart	2	Ikke-saproxyliske arter obligat tilknyttet nåletræer.
8	39	Fakultativ nåletræsart	2+3	Andre nåletræs-tilknyttede arter end gruppe 6 og 7, fx arter med behov for en blanding af nåletræer og løvtræer eller tilknyttet begge slags træer.
Total	626	Skovarter		

Zonetilhøret jf. tabel 2 blev justeret inden Marxan optimeringen for 15 % of de 626 skovarter i forbindelse med ovennævnte ekspertkonsultation, idet 94 arter fik ændret zonetilhør i forhold til udgangspunktet: 71 arter fik en ekstra zone, 5 arter en ændret zone og 18 arter en zone mindre for at matche artens præferencer bedre. De endelige zoner anvendt i Marxan optimeringen fremgår for hver skovart i bilag B sammen med andre artsspecifikke oplysninger.

4.2 Optimering for skovarter med programmet *Marxan with zones*

Opgaven med at finde en omkostningseffektiv måde at bevare skovarterne på svarer til at løse et "minimums-sæt" optimeringsproblem (Possingham et al. 2006). Det går ud på at nå kvantitative naturbevaringsformål billigst muligt ved at optimere hvilke områder, der skal udvælges til beskyttelse. I lyset af Aichi mål 12 blev det overordnede formål om at sikre levedygtige bestande af arterne kvantificeret til, at der på Naturstyrelsens arealer skulle sikres mindst 3 eller mindst 5 områder for hver 2020-måls-art med en beskyttelsestype (zone), som matchede artens økologiske behov.

Der er som nævnt i afsnit 2.7 ingen garanti for, at hverken 3 eller 5 områder vil være nok til at sikre en arts langsigtede overlevelse. For mange af de truede arter udgør 3 eller 5 områder dog 100 % af de kendte forekomster hos Naturstyrelsen, og for de fleste mindre sjældne arter vil antallet af beskyttede forekomster blive væsentligt højere end måltallet (Cabeza & Moilanen 2001, Justus et al. 2008, Petersen et al. 2016a, Tear et al. 2005). Derudover har mange af arterne også levesteder udenfor Naturstyrelsens arealer, herunder i fredede eller på anden måde naturbeskyttede områder.

For at kunne vurdere optimeringens følsomhed i forhold til usikkerheder for en række af de indgående data, blev der kørt en række scenarier med forskellige kombinationer af forudsætninger. Tabel 3 er en oversigt over forudsætninger og input for hvert af 26 scenarier. Ikke alle kombinationer af forudsætninger blev kørt som følge af det store antal (2*2*3*2*2*2*2=192) mulige kombinationer. I stedet blev scenarier kørt som successive parvise sammenligninger, hvor forudsætninger som gav relativt dyre, ineffektive eller urealistiske løsninger efterhånden blev sorteret fra.

Tabel 3. Overblik over forudsætninger i 26 kørte scenarier.

Scenarie	Mål antal skove	Tab Zone 2 (%)	Tab Zone 3 (%)	Prioritets arter med	Nåletræs tilknyttede arter med?	Antal arter med	Tab som penge eller areal?	Syv i forvejen urørte skove låst
A	Fem	25	100	A og B	Ja	626	Penge	Nej
B	Fem	25	100	A og B	Ja	626	Areal	Nej
C	Fem	25	100	A og B	Nej	516	Penge	Nej
D	Fem	25	100	A og B	Nej	516	Areal	Nej
E	Fem	25	100	Kun A	Ja	304	Penge	Nej
F	Fem	25	100	Kun A	Ja	304	Areal	Nej
G	Tre	25	100	Kun A	Ja	304	Penge	Nej
H	Tre	25	100	Kun A	Ja	304	Areal	Nej
I	Fem	25	75	A og B	Ja	626	Penge	Nej
J	Fem	25	75	A og B	Ja	626	Areal	Nej
K	Fem	25	75	A og B	Nej	516	Penge	Nej
L	Fem	25	75	A og B	Nej	516	Areal	Nej
M	Fem	25	75	Kun A	Ja	304	Penge	Nej
N	Fem	25	75	Kun A	Ja	304	Areal	Nej
O	Tre	25	75	Kun A	Ja	304	Penge	Ja til z4
P	Tre	25	75	Kun A	Ja	304	Areal	Ja til z4
Q	Fem	25	75	Kun A	Ja	304	Penge	Ja til z4
R	Fem	25	75	Kun A	Ja	304	Areal	Ja til z4
S	Fem	10	75	A og B	Ja	626	Penge	Ja til z4
T	Tre	10	75	A og B	Ja	626	Penge	Ja til z4
U	Fem	10	75	Kun A	Ja	304	Penge	Ja til z4
V	Tre	10	75	Kun A	Ja	304	Penge	Ja til z4
W	Fem	10	50	A og B	Ja	626	Penge	Ja til z4
X	Tre	10	50	A og B	Ja	626	Penge	Ja til z4
Y	Fem	10	50	Kun A	Ja	304	Penge	Ja til z4
Z	Tre	10	50	Kun A	Ja	304	Penge	Ja til z4

Tabet blev altid sat til 100 % i zone 4 (Urørt) og til 0 % i zone 1 (Normal).

Skovområder, som i forvejen var beskyttede som urørt skov, blev a priori låst til zone 4 (Urørt) i scenarie O – Z, hvis skoven levede op til følgende kriterier: 1) 100 % af statsskovens totalareal i forvejen besluttet som urørt skov OG det skovbevoksede areal udgør mindst 5 ha, ELLER 2) Mindst 100 ha skovbevokset i forvejen beskyttet som urørt OG det udgør mere end 45 % af statsskovens totalareal. Afskæringskriterierne 5 ha og 45 % blev valgt for at sikre, at store vigtige i forvejen urørte skove kom med, uden a priori at låse en lang liste af skove til zone 4. Syv skove levede op til kriterierne (Bilag C).

For at fungere kræver Marxan at alle områder har en omkostning større end nul, hvilket ikke var tilfældet i basistallene. Derfor blev alle omkostningstal for statsskove tillagt 1000 kr. før kalibreringer og kørsler. Samme beløb blev efter kørslerne fratrukket hver skovs beregnede tab.

For at levere valide robuste resultater og køre scenarier effektivt kræver Marxan desuden et antal standard kalibreringer vedrørende "arts-straf-faktor" (Species Penalty Factor, SPF), antal "runs" (gennemløb) og antal iterationer (Ardron et al. 2010, Segan et al. 2011, Watts et al. 2008a, 2008b, 2009, 2011). Som følge af at alle opstillede mål ikke var mulige at nå samtidig blev kalibrerings metoderne i Watts et al. (2008a) anvendt (Watts et al. 2011).

Kalibreringsprocessen førte til at en standard på 100 gennemløb blev valgt ligesom i Watts et al. (2008a), idet optimeringen ikke forbedredes ved at øge antallet yderligere. Optimeringen blev til gengæld forbedret i form af billigere løsninger helt op til lidt under 10 millioner iterationer, hvorfor det antal blev valgt trods øget tidsforbrug til kørslerne. Principielt kan kalibreringen af "arts-straf-faktorer" (SPF) være forskellig for penge- og areal-scenarier, men reelt påvirkede forskellen på den kalibrerede SPF for penge og for areal (henholdsvis 7,188 og 7,75) ikke optimeringen, hvorfor gennemsnitstallet på 7,47 blev anvendt. Alle tre kalibrerede faktorer blev holdt konstant gennem alle scenarier.

Hvert af de 26 scenarier tog ca. 6 minutter procestid og leverede et antal filer med detaljer om bl.a. skovenes tildelte zone, omkostningen derved, målopfyldelse pr. art og skov, samt scenariets "Objective function score". Sidstnævnte er Marxan-algoritmens samlede tal for optimeringen, hvor lave værdier er bedst.

Scenariernes succes blev ud over "Objective function score" vurderet i forhold til
1) økonomisk tab (årligt tab af nettoindkomst fra skovdrift), og
2) hvor mange af de 304 prioritet A arter, der når de konkrete måltal.

For arter med forekomst i færre statsskove end måltallet (3 eller 5) blev målet trunkeret til alle statsskove med forekomst af arten. Som et supplement og for at vurdere hvor langt fra målopfyldelse hvert scenarie var, blev den *gennemsnitlige målopfyldelse* (GM) for hver af de 304 prioritet A arter i hvert scenarie beregnet. Den gennemsnitlige målopfyldelse er lig 1, hvis alle arter når deres mål. Arter, som ikke nåede deres måltal, benævntes *gap-arter*, jf. det engelske ord "gap" (”hul”).

Eftersom Marxan optimeringen blev kørt på grundlag af de 976 administrativt fastlagte statsskovs-polygoner, kunne den kun levere resultater for dele af større skove, hvis disse dele havde en særskilt statsskovs-polygon. Det var fx tilfældet for Gribskov-komplekset, som var opdelt i flere mindre polygoner, mens de fleste andre skove i deres helhed omfattes af kun en polygon.

4.3 Yderligere optimering

Skovene i Marxans mest optimale scenarier blev efterfølgende gennemgået manuelt for at se på muligheder for yderligere optimering. Det viste sig nemlig umuligt ved Marxan optimeringen at få opfyldt målene for alle arter samtidig, idet en række skove rummede for mange sjældne arter med modstridende økologiske behov.

Den manuelle optimering startede med at undersøge den geografiske fordeling af prioritet A arternes behov i skove med gap-arter. Hvis behovene var grupperet på en sådan måde, at en underopdeling af skoven til mere end én beskyttelseszone kunne løse gap-artens behov uden at kompromittere de arter, som Marxan havde baseret sit zone-valg på, blev dette noteret som en mulighed.

Derudover blev gap-arternes data og økologiske behov gransket mere detaljeret ved yderligere litteratur- og database-søgning, hvis de var registreret præcis samme sted i skoven, som andre arter med modstridende behov, for at se om der eventuelt kunne være tale om fejl i data om fundet eller artens økologi. Andre økologiske behov, fx affinitet til specifikke jordbundsforhold, kunne i den forbindelse medvirke til forklaring.

Opdeling af skoven i mere end en zone blev valgt som anbefaling, hvor ovenstående tilgang viste, at gap-arterne kunne tilgodeses, uden at det gik ud over andre arters målopfyldelse.

I en teoretisk optimal situation kunne man have kørt optimeringen færdig i Marxan. Det ville have krævet, at man havde både økonomi- og artsdata i en meget finere geografisk skala end, hvad der er tilgængeligt eller realistisk.

4.4 Ikke-skovarter

I princippet kunne de arter, som ikke var skovarter, have været tildelt en speciel "ikke-skov" zone i Marxan analyserne og dermed være kørt med i Marxan optimeringen. Det var dog i praksis ikke muligt som følge af, at mange af statsskovs-polygonerne rummer både meget store og vigtige lysåbne biotoper foruden skov, hvilket Marxan ikke ville kunne håndtere hensigtsmæssigt med de foreliggende skov-niveau data. Desuden er de økonomiske omkostninger meget forskellige for de mange varierede beskyttelsestyper for lysåbne biotoper. Så én zone med én omkostning ville ikke give mening.

Det blev i stedet analyseret, om de steder, hvor ikke-skov-arterne var registreret, var beskyttet gennem de hidtidige strategier for naturbeskyttelse, og om de lå på Naturstyrelsens arealer. Der blev i den forbindelse udført en gap-analyse, der belyste, hvor godt de hidtidigt beskyttede arealer dækkede arterne, og det blev undersøgt, om der var væsentligt sammenfald mellem forekomst af globale, nationale og EU-truede arter.

Det blev desuden undersøgt, hvor og hvordan ændret indsats på Naturstyrelsens lysåbne arealer konkret kan bidrage målrettet til 2020-målet:

1) Kan der identificeres konkrete ubeskyttede lokaliteter med truede arter i prioritet 1 til 3?
2) Kendes arternes økologiske behov godt nok til at foreskrive ændret drift?
3) Kan nødvendige ændrede driftstiltag identificeres?
4) Kan prisen for de nødvendige driftsændringer beregnes?

Det var forventningen, at der for mange truede arter kunne identificeres en række lokaliteter, hvor den hidtidige forvaltning ikke passede til arternes økologiske behov, og der dermed kan anbefales ændret forvaltning.

Nedenstående kriterier blev valgt til brug for en afklaring af, hvor indsats burde prioriteres højest. Planlagt og igangværende forvaltning af Natura 2000 områderne modvirker generelt en række af de trusler, som skader truede arter, og vil derfor ikke kun gavne de arter, som var grundlag for udpegning af områderne, men også områdets øvrige truede arter med tilsvarende økologiske behov. En lang række indsatser er allerede i gang i Natura 2000 områderne som opfølgning på Natura 2000 planerne. I prioriteringssammenhæng vurderes disse steder ikke at være dem der trænger mest til supplerende indsats. Hvor der er tale om modstridende interesser for forskellige arter, vil udpegnings-grundlags arterne under alle omstændigheder have juridisk forrang. Dette er baggrunden for kriterierne om andel af forekomsten dækket af habitatområde (SAC) henholdsvis fuglebeskyttelsesområde (SPA). Tilsvarende overvejelser ligger bag medtagelsen af kriteriet om andel allerede stærkt beskyttet areal (IUCN kategori 1-2).

Følgende kriterier brugtes til identifikation af relativt ubeskyttede steder med **internationalt truede** arter, dvs. truet på globalt eller EU niveau:
• Globalt truet art, og dermed af særlig betydning for 2020-målet, dvs. prioritetsklasse 1.
• Rapporteret ugunstig i 2013 for EU arter (tilbagegang for fugle), dvs. prioritetsklasse 2.
• NST ejet lokalitet.
• IUCN kat 1-2 dækker < 10 % af forekomsten af arten på lokaliteten.
• For EU-Annex II arter dækker SAC < 10 % af arten på lokaliteten.
• For fugle dækker SPA udpegningsgrundlag ikke arten på lokaliteten.
• Væsentlig forekomst, så > 1 % af DKs registreringer er på lokaliteten.
• Dog > 0 % for globalt truede arter.
• Arten er ikke i markant fremgang og ikke med sikkerhed uddød.

Som følge af sidstnævnte kriterie udgik gråsæl og odder (markant fremgang) samt urfugl (uddød).

Følgende kriterier brugtes tilsvarende for **dansk truede** arter:
• Dansk truet art i tilbagegang, dvs. prioritetsklasse 3.
• NST ejet lokalitet.
• IUCN kat 1-2 dækker < 10 % af forekomsten af arten på lokaliteten.
• SAC dækker < 10 % af forekomsten af arten på lokaliteten.
• Væsentlig forekomst, så > 1 % af DKs registreringer er på lokaliteten.

På basis af kriterierne blev steder på Naturstyrelsens arealer identificeret, som vurderes at kunne have størst nytte af ændret eller ekstra beskyttelse for de 2020-måls-arter, der ikke er tilknyttet skov.

5. Resultater og diskussion

5.1 Oversigt over arternes status og prioritet

Fordelingen af 2020-måls-arter til artsgrupper og trussels geografi fremgår af tabel 4. Flere af de regionalt uddøde arter er genfundet siden 2010 rødlistningen, så kategorien RE er relevant at medtage.

*Tabel 4. Fordelingen af undersøgelsens 1932 arter *.*

Artsgruppe \ antal arter	DK_RE	DK_truet	EU	Global	I alt
Pattedyr	1	1	24		26
Fugle	3	18	54	1	76
Krybdyr	1		1		2
Padder			11		11
Insekter	142	498	7	7	654
Andre invertebrater	1	21	5	2	29
Svampe	21	528		3	552
Laver	96	293	7		396
Mos			41	1	42
Planter	22	108	14		144
I alt	287	1467	164	14	1932

** En del arter er truet på flere geografiske niveauer, men tælles her kun med i én, nemlig den mest globale. RE står for regionalt uddød. Truet omfatter kategorierne kritisk truet (CR), moderat truet (EN) og sårbar (VU). EU arterne omfatter annex 1 på fuglebeskyttelsesdirektivet og annex II, IV og V på habitatdirektivet.*

I alt blev ca. 22 millioner artsregistreringer (Bilag A) tjekket for 2020-måls-arterne. Det resulterede i funddata fra perioden 1991-2015 for 1378 (Tabel 5) af de potentielt mulige 1932 arter. Efter kvalitetssikring var der 267.438 stedfæstede forekomster for disse 1378 arter, som således indgik i det videre projekt.

Forskellen på 554 ikke registrerede arter udgøres hovedsagelig af 231 længe uddøde arter og af en lang række vanskeligt bestemmelige lav-arter, biller og jordmøl, som meget få personer kan kende, og som derfor enten ikke er eftersøgt, ikke fundet eller ikke registreret i de tilgængelige databaser.

Tabel 5. Fordelingen til artsgruppe af 2020-måls-arter fundet i DK 1991-2015 uanset ejer. De fem højre kolonner viser fordelingen af arterne til de anvendte prioritetsklasser.

Antal arter med fund	DK_RE	DK_truet	EU	Global	I alt	Pr1	Pr2	Pr3	Pr4	Pr5
Pattedyr	1	1	23		25		7	2	16	
Fugle	3	18	52	1	74	1	13	13	47	
Krybdyr			1		1		1			
Padder			11		11		9		2	
Insekter	29	328	7	5	369	5	6	277	81	
Andre invertebrater		17	5	2	24	2	2	8	12	
Svampe	7	510		3	520	3		206	311	
Laver	13	177	7		197			175	17	5
Mos			35		35		2		1	32
Planter	3	107	12		122		5	76	41	
I alt	56	1158	153	11	1378	11	45	757	528	37

Af de 1378 fundne arter (Tabel 5) er 1066 arter svarende til 77,4 % registreret på Naturstyrelsens arealer (Tabel 6), hvilket er de fund, som er særligt relevante for nærværende rapport, og som indgår i optimeringsdelen af projektet.

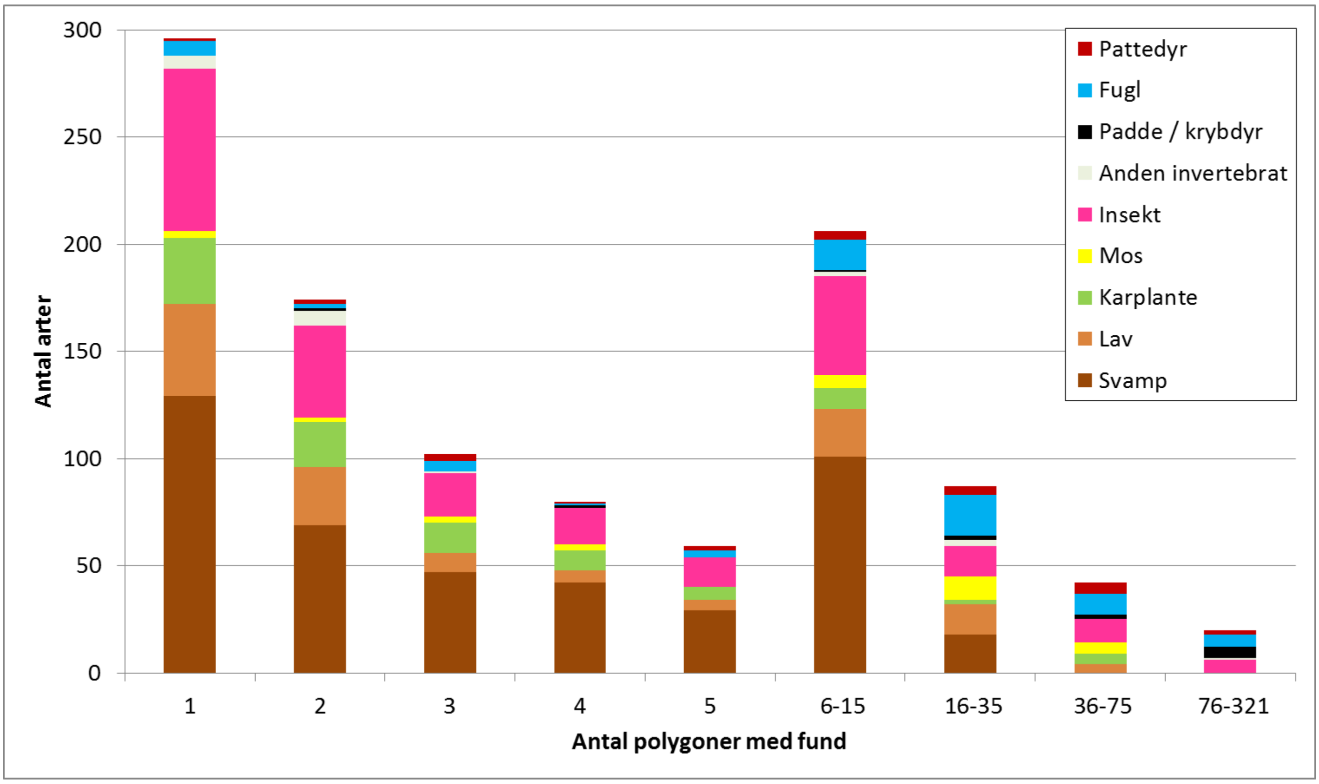
Tabel 6. Fordelingen af 2020-måls-arter fundet 1991-2015 på Naturstyrelsens arealer. De fem højre kolonner viser fordelingen af arterne til de anvendte prioritetsklasser.

Antal arter med fund	DK_RE	DK_truet	EU	Global	I alt	Pr1	Pr2	Pr3	Pr4	Pr5
Pattedyr		1	23		24		7	1	16	
Fugle	3	17	47		67		12	12	43	
Krybdyr			1		1		1			
Padder			11		11		9		2	
Insekter	16	219	7	5	247	5	6	188	48	
Andre invertebrater		14	4	2	20	2	1	7	10	
Svampe	4	429		2	435	2		178	255	
Laver	4	120	6		130			118	7	5
Mos			33		33		2		1	30
Planter	1	86	11		98		4	62	32	
I alt	28	886	143	9	1066	9	42	566	414	35

Ligesom en række jordmøl, biller og lavarter er mangelfuldt kendt og registreret, er forekomst og udvikling over tid også usikker for en del af de andre truede arter, som er vanskelige at registrere, eller som meget få personer kan kende. Oplysningerne, som ligger til grund for prioriteringerne, er derfor af varierende sikkerhed og dermed også prioriteringerne. Det gælder bl.a. vurderingen i rødlisten af, om en art er i tilbagegang eller ej. Dels er den udført af forskellige arts eksperter, dels skønnet over forskellige årrækker fra 10 til 100 år afhængigt af hver arts generationstid, som heller ikke altid kendes eksakt. Denne og andre usikkerheder, jf. afsnit 6, bør derfor haves in mente ved tolkning af resultater og prioriteringer.

Selvom en art evt. kun blev registreret tidligt i årrækken 1991-2015, vurderes det fortsat relevant at opretholde levestedet, idet en del af arterne lever skjult og kan være overset eller dukke op igen, ligesom andre truede arter ofte vil leve samme sted.

Det fremgår af figur 1, at 296 (27,8 %) af de 1066 2020-måls-arter kun er kendt fra ét af Naturstyrelsens polygoner, og yderligere en lang række arter kun fra 2, 3, 4 eller 5 polygoner. Hare (*Lepus europeaus*) var den mest udbredte art, registreret fra 321 statsskovs-polygoner.



Figur 1. Fordeling af 2020-måls-arterne til Naturstyrelsens 976 arealer. (N = 1066 arter)

5.2 Arternes præferencer

Fordelingen til skovarter og ikke-skovarter i relation til status og udviklingstrend fremgår af tabel 7 for arterne kendt fra Naturstyrelsens arealer. De udgjordes af 626 skovarter og 440 ikke-skovarter. For skovarterne er der rapporteret tilbagegang for 48,7 % inklusive globalt truede arter, mens det tilsvarende tal for ikke-skovarter er 70,9 %. Der er således flest arter knyttet til skov, men en relativt mindre del af skovarterne er vurderet i tilbagegang i forhold til arterne i andre biotoper.

Tabel 7. Fordeling af 2020-måls-arterne på skovarter og ikke-skovarter, samt prioriteter.

Prioritet	Status og geografi	Tilbagegang rapporteret?	Skovart (N)	Ikke-skovart (N)	Total (N)
A1	Globalt truet (IUCN redlist CR, EN eller VU)	Ja eller nej	3	6	9
A2	EU rapporteringsart jf. fugle- eller habitat-direktiv	Ja	12	30	42
A3	Dansk Rødliste 2010 (RE, CR, EN eller VU)	Ja	290	276	566
B 4+5	Dansk Rødliste 2010 (RE, CR, EN eller VU) eller EU rapporteringsart.	Nej	321	128	449
Total			626	440	1066

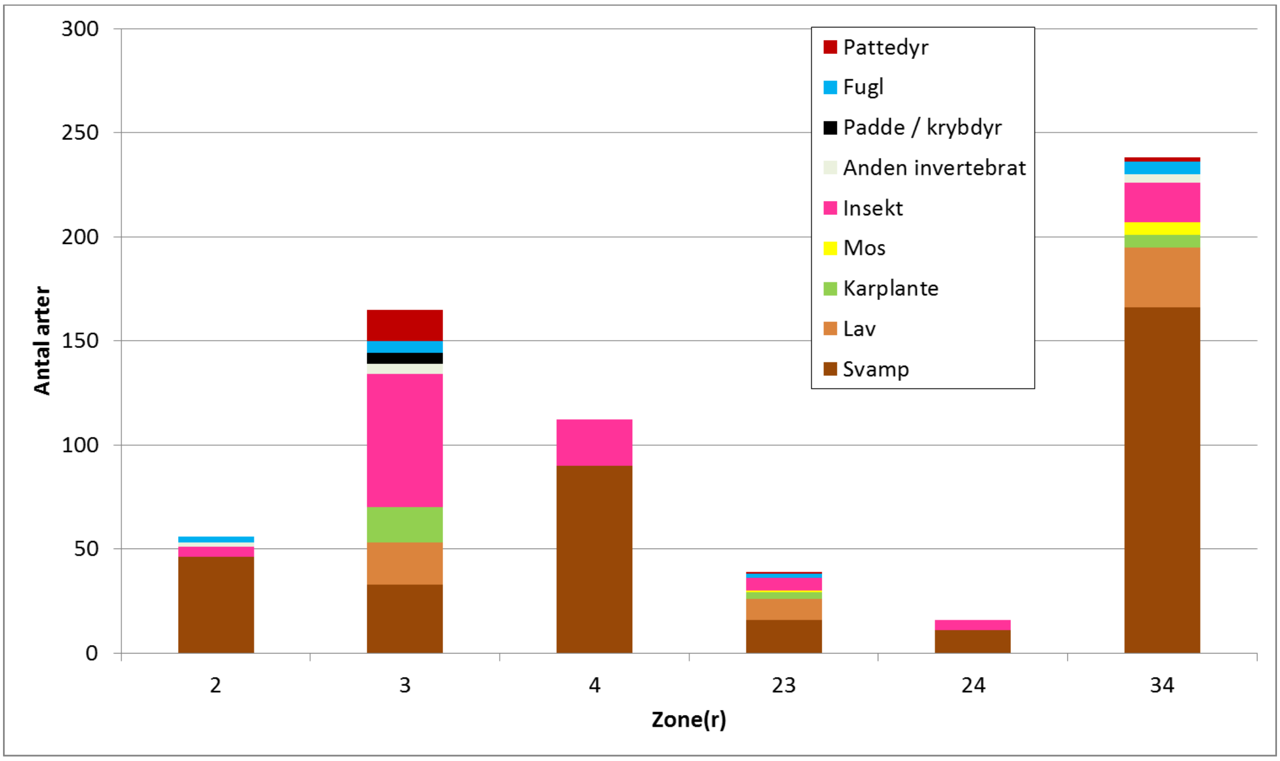
Blandt skovarterne var 156 arter (24,9 %) saproxyliske, heraf 105 svampe, 50 insekter og 1 mosskorpion (Tabel 8). Af de 626 skovarter var 110 arter (18 %) mere tilknyttet nåletræer end de var tilknyttet løvtræer.

Tabel 8. Fordeling til præferencer for 2020-måls-arter fra Naturstyrelsens arealer.

Arter (N)	Obligate skovarter	Fakultative skovarter	Ikke-skovarter	Total
Saproxyliske	118 (16)	38	0	156 (16)
Ikke-saproxyliske	296 (68)	174 (26)	440	910 (94)
Total	414 (84)	212 (26)	440	1066 (110)

I parentes vises antal arter der foretrækker nåletræer (nuller udeladt). Fakultative skovarter inkluderer arter, som også eller primært lever i åbne biotoper som fx vandhuller, enge, heder eller overdrev.

Figur 2 viser fordelingen på zoner for de 626 skovarter kendt fra Naturstyrelsens arealer. Zone affiniteterne er baseret på arternes forskellige økologiske behov og præferencer efter artseksperternes bidrag. Det fremgår, at en stor del af arterne vurderes at kunne få opfyldt deres behov på mere end én måde ved fx både at kunne trives i urørt skov (zone 4) og i skov med mere aktiv beskyttelse (zone 3). Sådanne arter noteres med begge zonenumre, fx 34. Endvidere fremgår det af figuren, at svampe og insekter udgør en meget væsentlig del af arterne, hvilket er i overensstemmelse med, at disse artsgrupper er langt de mest artsrige generelt.



Figur 2. Antal arter sammenholdt med behov for beskyttelse omsat til zoner. 2 = zone 2 (Nål); 3 = zone 3 (Aktiv); 4 = zone 4 (Urørt); 23, 24 og 34: både den ene og den anden nævnte zone kan opfylde artens økologiske behov. N = 626 skovarter kendt fra Naturstyrelsens arealer.

5.3 Marxan-optimering for skovarter

I 692 (70.9 %) af de 976 polygoner, som statsskovene opdeles i, var der i perioden 1991-2015 registreret en eller flere af de 1066 forskellige 2020-måls-arter. Alle polygoner med mindst en af de 626 skovarter blev medtaget i Marxan analyserne (670 polygoner med et samlet skovbevokset areal på 103.234 ha). De øvrige 306 statsskov polygoner uden kendt forekomst af relevante skovarter var fx søer, P-pladser, heder mv uden skov, eller ret små skove (samlet skovbevokset areal 2.684 ha). De blev manuelt ført til zone 1 (Normal).

Syv skove var hot spots med mindst 100 af 2020-måls-arterne. De var alle mindst 538 ha store. Seks af dem (86 %) var allerede delvis beskyttet på en måde som svarer til enten Aktiv zonen (1-87 % af hver skov) eller Urørt zonen (3-24 % af hver skov). Den nåletræsdominerede plantage Tisvilde Hegn var den mest artsrige skov med 192 2020-måls-arter, heraf 126 skovarter. For løvskove var Klinteskov på Møn artsrigest med 179 2020-måls-arter, heraf 133 skovarter. To andre skove havde også mere end 100 skovarter, nemlig Gribskov med 120 og Jægersborg Dyrehave med 116 skovarter.

For 450 statsskove var allokering til zone ens for alle 26 Marxan-scenarier. Når ovennævnte 306 zone 1 skove medregnes, blev i alt 756 (77.5 %) skove dermed systematisk placeret i samme zone hver gang uanset de variable forudsætninger (Tabel 9).

Tabel 9. Fordeling til zoner af de 976 statsskove i 26 scenarier.

	Kort navn	Skove (N)	Skovbevokset areal (ha)	Penge værdi (%)	Detaljer
Altid zone 4	Urørt	20	7.824	11	Bilag D
Altid zone 3	Aktiv	55	9.044	9	Bilag E
Altid zone 2	Nål	0	0	0	Ingen
Zone variabel	-	220	62.253	59	Bilag F
Altid zone 1	Normal	681	26.797	21	Bilag G
Total		976	105.918	100	

Detaljer om hver skov kan ses i bilag D til G (areal, skovtyper, eksisterende beskyttelse, MxZ zone, artsantal, procent af observationer fra i forvejen beskyttede dele af skoven, og zone resultater for scenarie O og Q, hvis zone var variabel).

Afhængigt af scenarie endte 26-58 % af statsskovenes skovbevoksede areal i zone 1 (Normal), mens 9-24 % endte i zone 4 (Urørt) (Tabel 10 og bilag H). Også zone 2 (Nål) og zone 3 (Aktiv) med henholdsvis 0-24 % og 15-41 % var følsomme for ændringer i forudsætninger. Tabet i form af nedgang i årlig netto indkomst fra skovdrift varierede over scenarier fra 26-69 % (Tabel 10 og bilag H).

Tabel 10. Gennemsnit for de 26 scenarier grupperet ud fra forudsætninger og antal arter, og sorteret efter måltal og mål nået.

Mål	Mål nået (af 304 arter)	Scenarier	Antal scen-arier	Antal arter med	Tabs forud-sæt-ninger	z1 areal %	z2 areal %	z3 areal %	z4 areal %	Tabs %	z4 (ha)	z4 (n)
3	255	TX	2	626	Lave	36	24	24	16	36 - 43	17338	61
3	259	GHOPVZ	6	304	Høj - lav	58	13	18	11	26 - 37	11565	40
5	199	CDKL	4	516	Høje	39	0	39	21	58 - 69	22606	80
5	218	ABIJSW	6	626	Høj - lav	26	24	29	20	43 - 61	21623	74
5	230	EFMNR	5	304	Høje	38	20	27	16	46 - 54	16483	51
5	231	QUY	3	304	Middel -lave	37	20	29	14	38 - 46	15281	50

z = zone. Alle arealer gælder skovbevokset areal, dvs. åbne områder som græsland og hede mv. er udeladt. Max-min er kun vist for Tabs %, fordi der var meget begrænset variation omkring gennemsnittene for de øvrige kolonner. Se bilag H for detaljerede resultater for hvert scenarie.

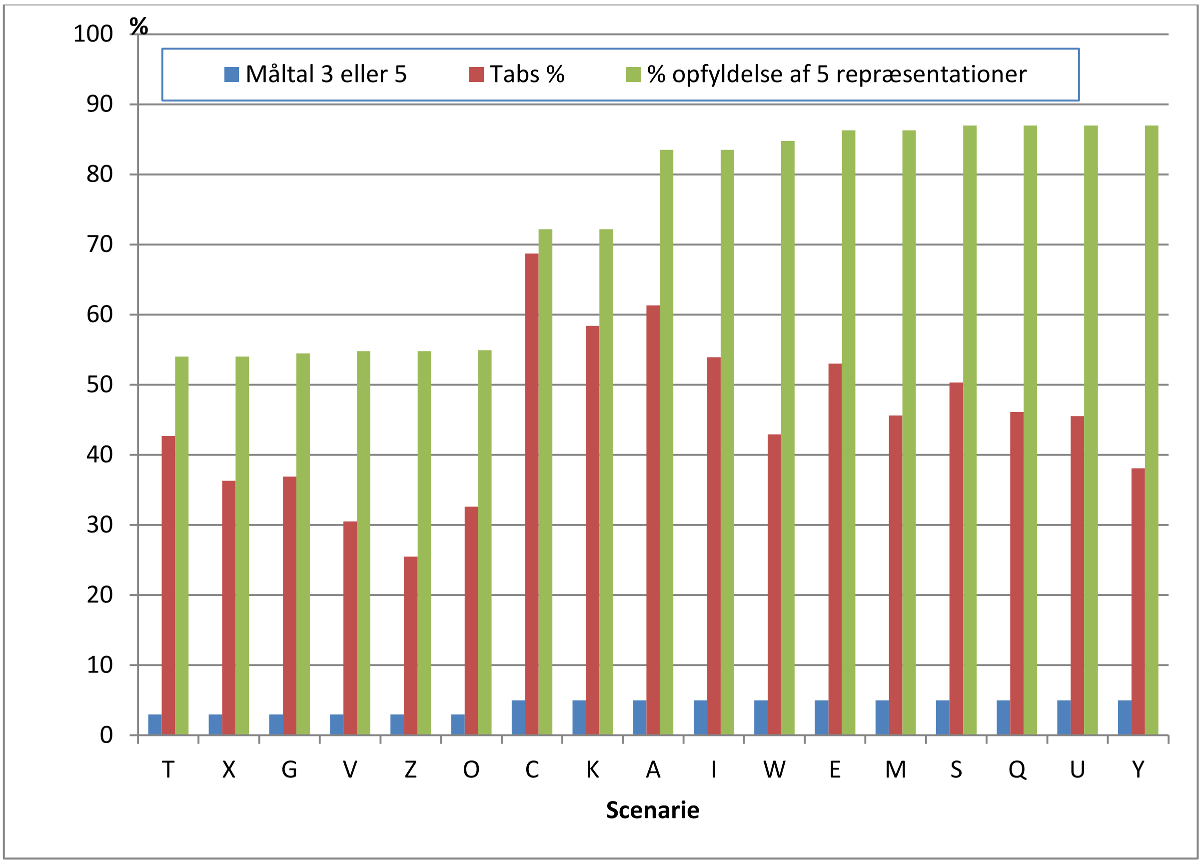
De første 18 scenarier (A-R) var parvis ens bortset fra, at omkostningen skiftede mellem penge og areal (Tabel 3 & bilag H). I gennemsnit var løsningerne 0,16 % dyrere, hvis tabt areal blev brugt som omkostningsparameter i stedet for økonomisk tab (samlet spænd var fra 0,72 % billigere til 1,02 % dyrere). Antal prioritet A arter med målopfyldelse var i gennemsnit 0,07 % bedre for areal-baserede scenarier (0,93 % værre til 1,29 % bedre). Eftersom alle disse forskelle vurderedes små og uvæsentlige i forhold til øvrige usikkerheder, og fordi det økonomiske tab blev anset for mest relevant, blev de efterfølgende 8 scenarier kun kørt med økonomisk tab.

Udelukkelse af arter med præference for nåletræer (Scenarie C, D, K, L) var 8,3 til 12,0 % dyrere end at medtage dem, uden forbedret målopfyldelse (Tabel 10 & bilag H). Årsagen var, at ingen skove kom i den relativt billige zone 2 (Nål), således at al beskyttelse også af arter med relativt brede præferencer blev nødt til at ske i de dyrere zoner 3 og 4. Fx kan visse sommerfugle trives i lysninger i både løv- og nåleskov. Samtidig fik de nåleskovs tilknyttede arter ikke deres økologiske behov tilgodeset. Omkostningerne for zone 2 (Nål) var sat lavere end for zone 3 (Aktiv), fordi mange af de truede zone 2 arter, fx fuglene natravn (*Caprimulgus europaeus*), hedelærke (*Lullula arborea*), nøddekrige (*Nucifraga caryocatactes*) og perleugle (*Aegolius funereus*) foruden den globalt truede blank gæstemyre (*Formicoxenus nitidulus)* kan trives med en mere eller mindre normal nåleskovsdrift eventuelt med mindre justeringer. Af ovenstående grunde blev de nåletræs tilknyttede arter ikke udelukket i de følgende scenarier.

Scenarier med både prioritet A og B arter (scenarie A, B, I, J, S, T, W, X) var 11-43 % dyrere og med 1,2-7,3 % lavere målopfyldelse end scenarier baseret alene på prioritet A arter. Sænkning af de forudsatte omkostninger fra fx 100 til 75 % (zone 3) eller fra 25 til 10 % (zone 2) resulterede selvfølgelig i billigere resultater, men ændrede ikke (scenarie A/I, B/J, E/M, F/N, Q/U, S/W, T/X, U/Y, V/Z) eller kun marginalt (O/V) på målopfyldelsen, hvilket indikerede, at det primært var de biologiske input data, der drev zoneringen (Tabel 10 & bilag H).

Således var zone konstellationen identisk for scenarie Q, U og Y uanset, at omkostningerne blev ændret fra 75/25 % over 75/10 % til 50/10 %. Zone konstellationen var tilsvarende næsten identisk for scenarie O, V og Z. Det viste sig således generelt, at zonerings resultaterne var meget lidt følsomme for ændringer i de økonomiske forudsætninger.

Ændring af måltallet fra 5 til 3 repræsentationer af hver art havde betydelig indflydelse på resultaterne jf. fx scenarie G i forhold til E eller scenarie O sammenlignet med Q (Tabel 10 & bilag H). I begge tilfælde opnår ca. 30 flere (12-13 %) prioritet A arter deres måltal med en kraftigt sænket (-29,5 til -30,4 %) omkostning. Det må så i den forbindelse huskes, at det absolutte beskyttelsesniveau er væsentligt ringere end i 5 repræsentations scenarierne (Figur 3). Scenarie Q/U/Y med 5 repræsentationer havde fx næsten ligeså mange arter (258/258/258) repræsenteret 3 gange som de tilsvarende 3-repræsentations scenarier O/V/Z (261/258/258) og havde derudover mange flere arter dækket 5 gange.

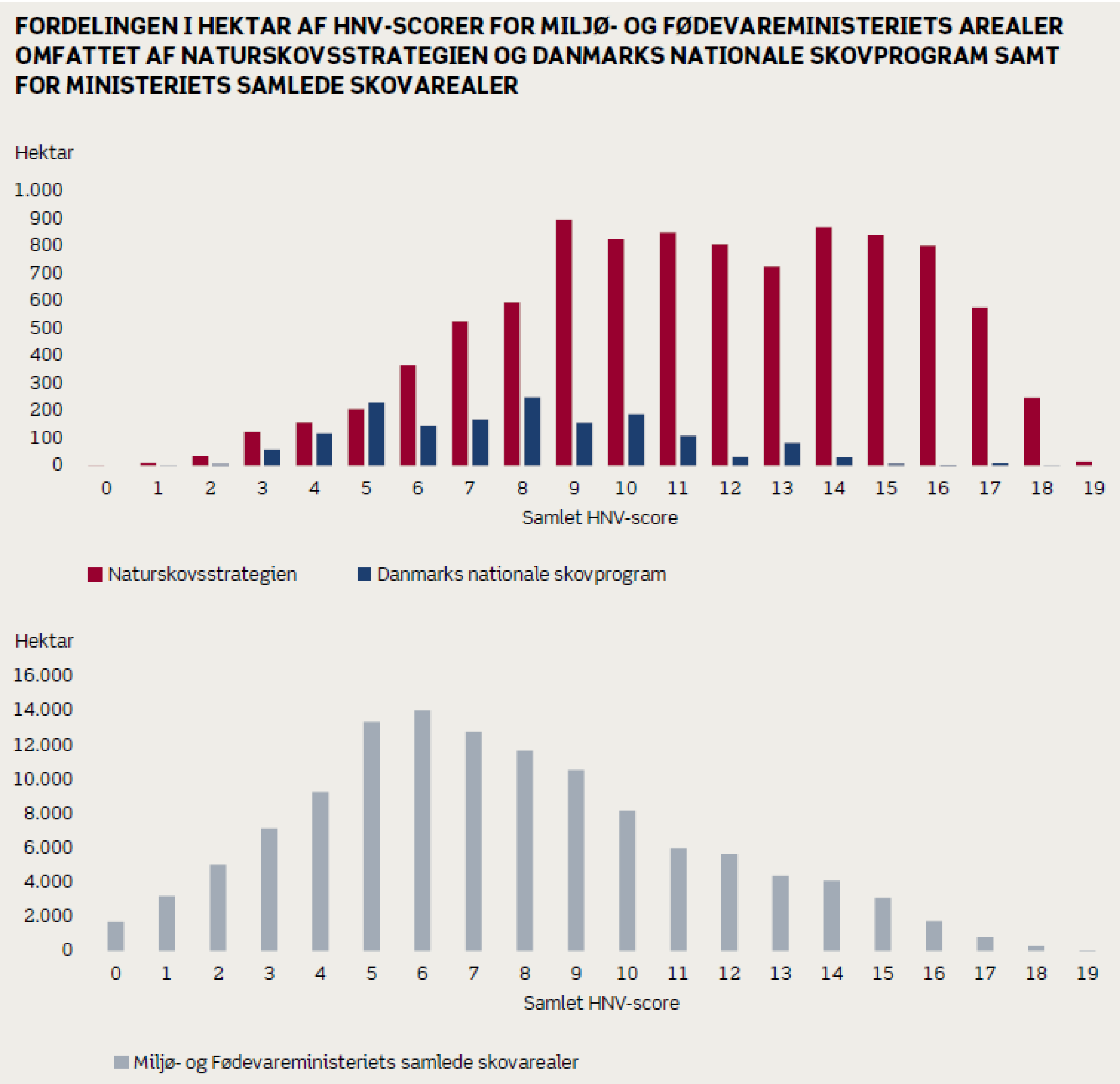


Figur 3. De pengebaserede scenarier sorteret efter måltal, relativ opfyldelse af 5 repræsentationsmålet, og endelig efter tabs %. De mest omkostnings effektive scenarier er til højre.

A priori låsning af syv i forvejen urørte skove (Bilag C) til zone 4 (scenarie Q sammenlignet med M) medførte forbedret målopfyldelse til det højeste niveau af alle pengebaserede 5-repræsentations scenarier, idet 231 i stedet for 229 arter nåede målet, og den gennemsnitlige målopfyldelsesgrad GM steg 0,78 % (Tabel 10 & bilag H). Til gengæld var løsningen 1,1 % dyrere. Forbedret målopfyldelse var modsat det forventede, eftersom de syv urørte skove, bortset fra Vorsø, blev besluttet lagt urørt i medfør af Naturskovsstrategien i 1990'erne baseret alene på den tids tilgængelige data og vurderinger, samtidig med at det ikke var forventet, at en sådan låsning af Marxans valgmuligheder kunne give en bedre målopfyldelse, end den løsning Marxan selv fandt optimal. Eksemplet demonstrerer, at Marxan algoritmerne ikke simpelt maksimerer målopfyldelsen, men finder en nær-optimal løsning balanceret mellem målopfyldelse og omkostningsminimering, uden at den nødvendigvis er den teoretisk optimale. Da målopfyldelse havde høj prioritet, og fjernelse af beskyttet urørt skov ikke var en del af opgaven, blev alle efterfølgende scenarier kørt med de syv skove låst til zone 4 (Urørt).

Resultatet af scenarie Q med låsning af de syv skove a priori til urørt viser også, at udpegningerne af urørt skov i medfør af Naturskovsstrategien må have været biodiversitetsmæssigt gode valg og bedre end tilfældigt, hvilket også fremgik af Rigsrevisionens undersøgelse (2016) af Miljø- og Fødevareministeriets forvaltning af biodiversitet i statsskovene (figur 4).

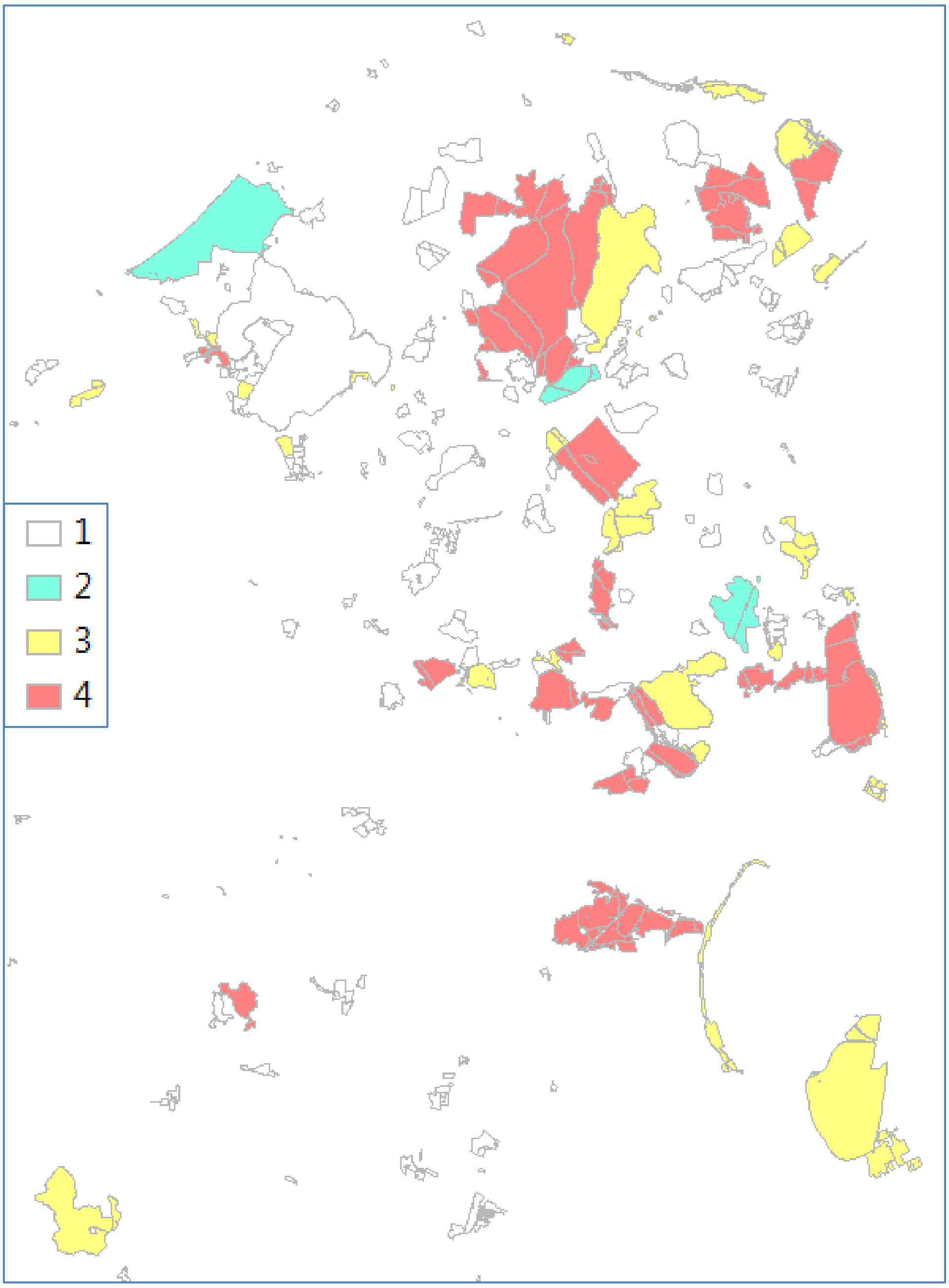
Det er ikke helt ligetil at kombinere ovenstående resultater til en vurdering af, hvilken konstellation af zoner og skove, der er bedst i relation til omkostningseffektiv beskyttelse af biodiversitet og udmøntning af Naturpakken. Det må gøres separat for henholdsvis 3 og 5 repræsentations-målene, med fokus på de realistiske scenarier O til Z med de i forvejen urørte skove låst til zone 4 (Urørt).



Figur 4. High-Nature-Value (HNV) scorer for arealer, der blev udlagt som biodiversitetsskov på baggrund af Naturskovsstrategien (rød), for Miljø- og Fødevareministeriets samlede skovarealer (grå), henholdsvis for arealer, der blev udlagt på baggrund af Danmarks nationale skovprogram (blå). Biodiversitetsværdien er ud fra HNV-skovkortet udtrykt ved en HNV-score på mellem 0 og 19, hvor 19 er det mest værdifulde. Fra Rigsrevisionen (2016).

For tre repræsentationer havde scenarie O og P bedst målopfyldelse og samtidig de tredje og fjerde laveste økonomiske tab af alle scenarier, hvilket viser, at de var omkostnings-effektive.

For fem repræsentationer havde scenarie Q, U og Y bedst målopfyldelse og identisk zoneskov fordeling, samtidig med, at de havde lavest økonomisk tab af scenarier med fem repræsentationer. Deres absolutte repræsentation af arter var højere end i scenarie O og P. Alle scenarie O skove blev også valgt i scenarie Q, U og Y. I forhold til scenario P var der blot én zone 2 (Nål) skov, som ikke igen blev valgt i scenarie Q, U og Y. Figur 5 viser et eksempel fra Nordsjælland på fordelingen af skove i scenarie Q.



Figur 5. Eksempel fra nordøstlige Sjælland på udfaldet til beskyttelseszoner af Marxan optimering, scenarie Q. Alle arealer forvaltet af Naturstyrelsen er vist og fordelt med farve til zoner. 1 = zone 1 (Normal). 2 = zone 2 (Nål). 3 = zone 3 (Aktiv). 4 = zone 4 (Urørt). Kystlinje er udeladt for ikke at skjule polygondetaljer. Helsingør er øverst til højre, Amager nederst til højre, og Bidstrup-Hvalsø skovene nederst t.v.

Den zone-skov konstellation, som scenarie Q, U og Y var fælles om, var upåvirket af variationen i de økonomiske forudsætninger og var på den måde robust. Samtidig havde den maksimal absolut målopfyldelse. Tabet ved scenarie Q, U og Y varierede fra 38-46 % af årlig nettoindkomst afhængig af de økonomiske forudsætninger. Dermed var disse scenarier de mest omkostnings-effektive scenarier med fem repræsentationer.

Zone-skov konstellationen i scenario Q, U og Y havde 50 skove i zone 4 (Urørt) med i alt 15.281 skovbevoksede hektar. Heraf har 2.256 ha været beskyttet som urørt i hvert fald siden år 2000, ud over at 2.676 ha i forvejen er udlagt med ekstra beskyttelse for biodiversitet i stil med zone 3 (Aktiv), fx som græsningsskov, stævningsskov eller plukhugst. Arealet allokeret til zone 4 (Urørt) kun med hidtidig normal statsskovs beskyttelse i forvejen udgjorde således 10.349 ha sammenligneligt med Naturpakkens ambitionsniveau på 10.000 ha ny urørt skov i statsskovene. Af ovenstående årsager toges der i det videre arbejde udgangspunkt i zone-skov konstellationen fra scenario Q (som altså var lig scenarie U og Y).

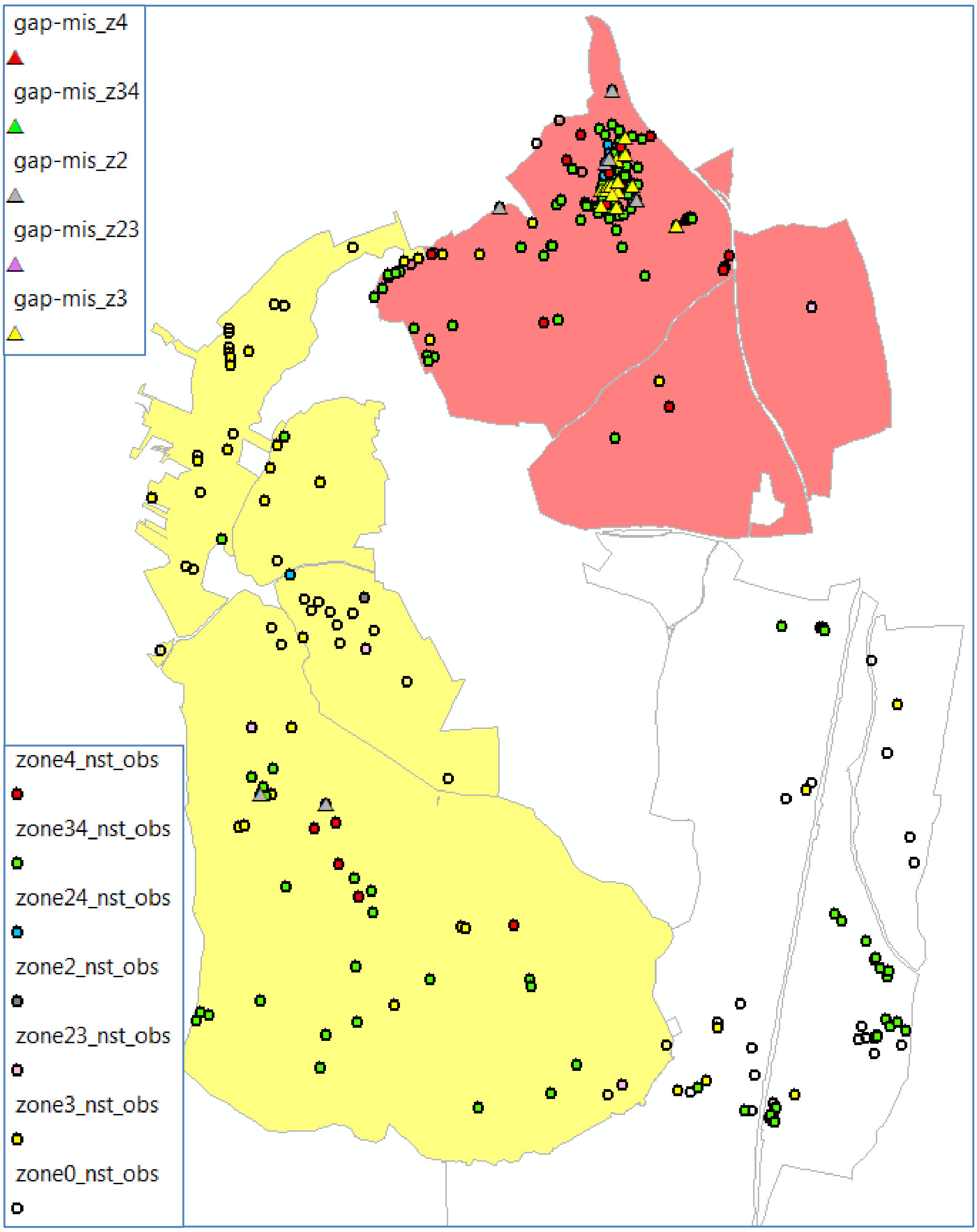
Samtidig viste analyserne, at behovet for andre typer ny biodiversitetsskov (zone 2 og 3) er mange gange højere end arealet på 3.300 ha anden biodiversitetsskov besluttet i Naturpakken. En stor del af de konkrete arealer med 2020-måls-arter, som analyserne foreslog til zone 2 og 3, kunne dog ved tjek mod de detaljerede GIS-data ses at være beskyttet allerede med gamle driftsformer, § 3-biotop eller på anden vis, eller var baseret på arter med behov for nåleskov, som langt hen ad vejen kan tilgodeses i Naturstyrelsens almindelige drift. Det viser behovet for at have fokus på de lys- og varmekrævende truede arter overalt på Naturstyrelsens arealer, og af at have et fortsat højt generelt beskyttelsesniveau. Mange zone 3 (Aktiv) arter må forventes at kunne få deres økologiske behov opfyldt også på arealer i almindelig drift, herunder i bryn og bræmmer, samt lysninger og søbredder mv.

Som nævnt var der ingen scenarier, der kunne opnå målopfyldelse for samtlige arter. Selv scenarie P, som var bedst af 3 repræsentations scenarierne, missede målet for 42 af de 304 prioritet A arter. Disse såkaldte gap-arter forekom i skove, som Marxan havde tildelt en anden og for gap-arten uegnet zone grundet optimering for andre tilstedeværende arter med andre økologiske behov. For at opnå en højere samlet målopfyldelse i optimeringen er det nødvendigt med mere end én beskyttelsestype (zone) i visse skove med gap-arter med modsatrettede økologiske behov, fx skove med en gap-art tilknyttet nåleskov i en del af skoven og andre truede arter med behov for fx lysåben egeskov eller urørt løvskov i en anden del.

De arter, som ikke nåede deres måltal, var ens for scenarie Q, U og Y. Disse i alt 73 gap-arter listes i bilag I med artsdetaljer, og indgik i den følgende proces med yderligere optimering gennem opdeling af skove til flere zoner.

5.4 Yderligere optimering ved opdeling af skove

Som beskrevet i afsnit 3.2 blev alle artsfund kvalitetssikret og lagt ind i Geografisk Informations System (GIS), så man kunne se arternes placering i skoven, og med hvilken præcision lokaliteten var noteret. Hvert artsfund blev kodet med en farve repræsenterende artens præference for zone(r). Disse detaljerede GIS data blev brugt til manuel analyse af, hvor gap-arterne var i forhold til andre truede arter med forskellige økologiske behov, med henblik på om opdeling af skoven til mere end en zone kunne hjælpe på målopfyldelsen (Figur 6).



Figur 6. Eksempel fra Naturstyrelsens dele af Rold Skov på meget ujævn fordeling af 2020-måls-arter i skovene. Gap-arter, som ikke i Marxan scenarie Q har fået deres præferencer opfyldt, vises med trekanter, mens arter, som har nået deres måltal, vises med cirkler. Zone0_obs er observationer af truede ikke-skovarter.

Det fremgår af ovenstående afsnit 5.3 om Marxan optimering for hele skov-polygoner, at det for 73 gap-arter (Bilag I) ikke kunne lade sig gøre at opfylde artens behov i mindst 5 forskellige skove. I alt 48 forskellige statsskove (Tabel 11 og bilag J) blev derfor gennemgået for yderligere optimering, fordi de havde forekomst af en eller flere gap-arter, men var tildelt en zone, som ikke passede med gap-artens behov. I 43 af disse skove blev den Marxan optimerede zone ændret til en eller flere andre zoner, mens 5 skove forblev uændret, idet nærmere granskning viste, at den konkrete gap-arts behov var fejlagtigt eller for snævert defineret (Bilag J). Derved kunne alle prioritet A arter få deres præferencer opfyldt mindst 5 gange eller alle steder, hvis de kun kendtes fra mindre end 5 statsskove.

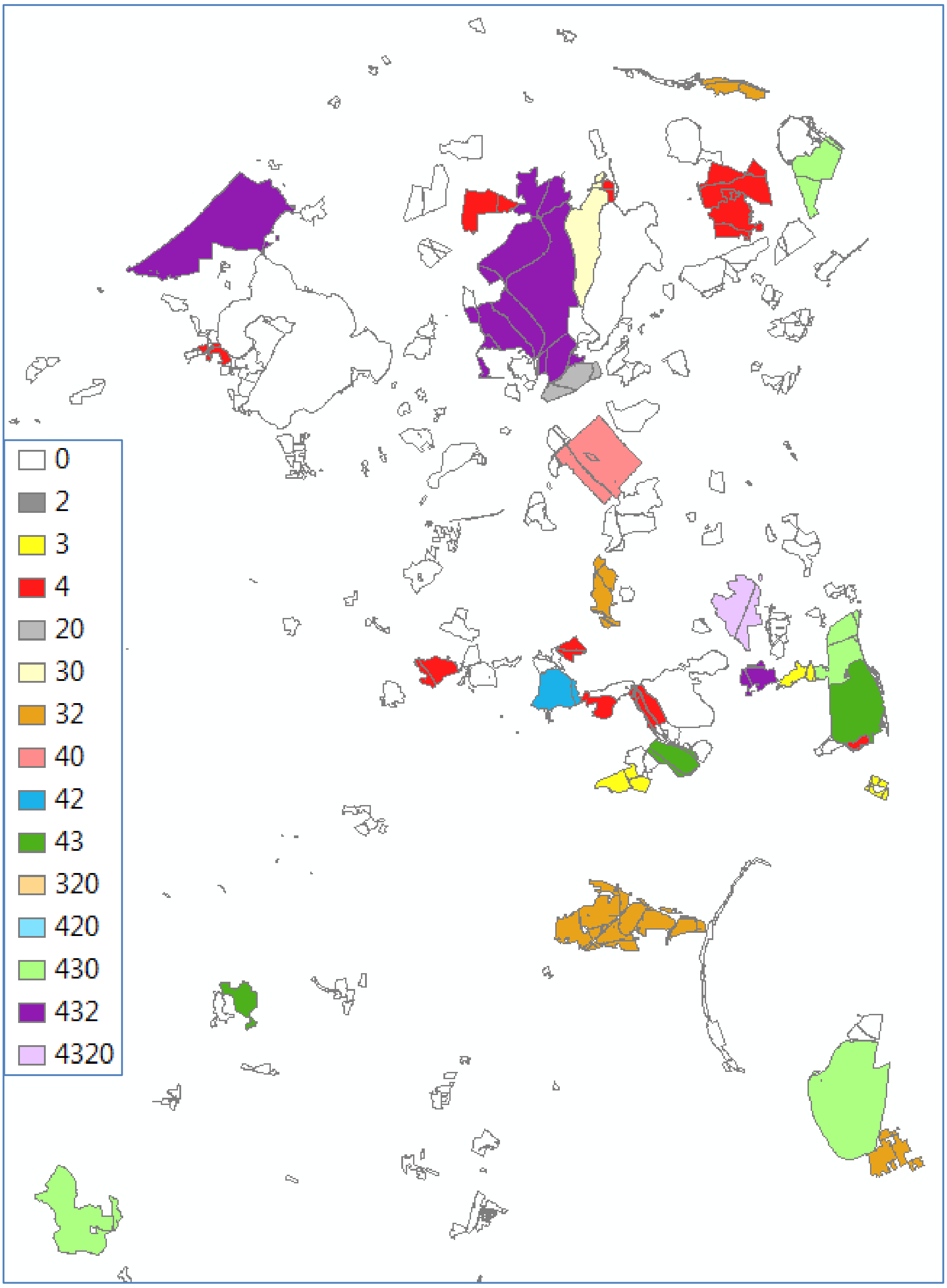
Tabel 11. Antal skovpolygoner, som blev vurderet i den manuelle proces. Øverste titelrække er de zoner, som Marxan scenarie Q tildelte, mens tallene i venstre kolonne beskriver hvilke zoner, skovpolygonen kunne opdeles i for at tage hensyn til gap-arter. I visse skovpolygoner blev der yderligere tilføjet et 0 som indikation af, at der yderligere var forekomst af truede ikke-skovarter, jf. bilag J.

Zoner manuelt	Zone 2 (Nål) skove	Zone 3 (Aktiv) skove	Zone 4 (Urørt) skove	I alt
Zone 3		2	2	4
Zone 4			3	3
Zone 3 / 2	4	9	2	15
Zone 4 / 2	1		1	2
Zone 4 / 3		4	10	14
Zone 4 / 3 / 2	2	3	5	10
I alt	7	18	23	48

Der blev ikke beregnet økonomi på den manuelle optimering, fordi økonomi tallene ikke forelå på en form, som tillod opsplitning, og fordi den manuelle gennemgang kun pegede på den principielle mulighed for yderligere optimering, men ikke pegede præcist på, hvor og hvordan opdeling kunne ske. Figur 7 viser som kort et eksempel fra den manuelle optimering.

Resultaterne af optimeringsarbejdet blev afleveret på elektronisk form (Excel- og ArcGis-fil) til Naturstyrelsen i november 2017 til brug for styrelsens udarbejdelse af forslag til udmøntning af Naturpakken. Styrelsen fik samtidig leverancer fra Københavns og Århus Universiteter (Johannsen & Schmidt 2017, Petersen et al. 2017) med bl.a. strukturbaserede analyser, som ved at indgå i styrelsens videre proces styrker beslutningsgrundlaget for hvilke skove, der er mest egnede til udpegning som fremtidigt urørte skov og anden biodiversitetsskov. Ved at kombinere analyser baseret på skov-, landskabs- og habitatstrukturer samt skovhistorie kan der nemlig opnås en uafhængig proxy, som kan bruges til forudsigelse af, hvor der med en vis sandsynlighed kan forventes forekomst af truede arter (Johannsen et al. 2015).

Til den videre regeringsproces med udpegning af urørt skov og biodiversitetsskov indgik også hensyntagen til juridiske forpligtelser som fredninger, kulturmindebeskyttelse og vandløbslov mv, samt andre hensyn som fx friluftsliv og generel omkostningseffektivitet. De endelige udpegninger vil dermed afvige fra de optimerede løsninger foreslået af Marxan og også fra den efterfølgende manuelle deloptimering. Det er helt i tråd med internationale erfaringer og med hele ideen med Marxan som et beslutnings understøttende værktøj (Schröter et al. 2014).



Figur 7. Eksempel fra nordøstlige Sjælland på udfaldet til beskyttelseszoner efter manuel optimering af scenarie Q. Alle arealer forvaltet af Naturstyrelsen er vist og fordelt med farve til zoner. 0 = Normal zonen inklusive behov for hensyn til truede ikke-skovarter. 2 = zone 2 (Nål). 3 = zone 3 (Aktiv). 4 = zone 4 (Urørt). Kystlinje er udeladt for ikke at skjule polygondetaljer. Sammenlign med figur 5.

5.5 Behov for ekstra beskyttelse af ikke-skovarter

Som beskrevet i afsnit 2.5 var det desværre ikke muligt at behandle skovarter og andre arter samlet i en fælles optimering. I nærværende afsnit omtales resultater for ikke-skovarter med enkelte koblinger også til skovarterne, som indtil Marxan analyserne beskrevet i afsnit 4.2 blev analyseret sammen med ikke-skovarterne.

Analyserne af både skov- og andre arters geografiske forekomster viste, at der var meget stort sammenfald mellem forekomst af globalt, nationalt og EU truede arter, idet de habitatområder, som er udpeget på grundlag af habitatdirektivets annex II arter fx repræsenterede 88 % af alle de andre truede arter og i gennemsnit dækkede 42 til 64 % af samtlige arts-forekomster. Det på trods af at habitatområderne tilsammen kun dækker ca. 8,6 % af Danmark (marine områder udeladt). Den hidtidige beskyttelse i form af habitatområder var desuden signifikant og væsentligt bedre placeret end tilfældigt (Buchwald & Heilmann-Clausen, in prep.).

De nævnte analyser medvirkede til udformningen af prioriteringskriterierne i afsnit 4.4. På basis af de opstillede prioriterings kriterier blev alle registreringer af truede arter på Naturstyrelsens arealer 1991 – 2015 gennemgået, og de sted-art kombinationer udtrukket, som matchede kriterierne (Tabel 12). Selvom en art evt. kun blev registreret tidligt i årrækken, vurderedes det fortsat relevant at opretholde levestedet, idet en del af arterne lever skjult og kan være overset eller dukke op igen, ligesom andre truede arter ifølge analyserne ofte vil leve der.

Tabel 12. Fordeling til skovarter og andre arter af sted-art kombinationer, som matcher de opstillede prioriterings kriterier. Tallene angiver antal sted-art kombinationer, hvor indsats ud over Natura 2000 indsatsen og anden hidtidig beskyttelse vurderes højt prioriteret for at sikre levestederne.

Truet hvor?	Skov arter	Andre arter	I alt
Globalt	8	26	34
EU	37	38	75
DK	631	306	937
I alt	676	370	1046

Herefter var fokus på ikke-skovarterne, idet skovarterne, som gennemgået i afsnit 5.3 - 5.4, blev analyseret uddybende i en særskilt optimeringsproces med inddragelse af økonomien. De 370 sted-art kombinationer for andre arter dækker over 158 arter og 175 forskellige skovnavne (inkl. lysåbne dele) hos Naturstyrelsen. Hver af de 175 skove rummer altså i gennemsnit ca. to af de omhandlede 158 arter, og maksimalt ti forskellige arter. To forskellige skove rummer hver ti arter, nemlig Høgdal ved Silkeborg og Skagen Plantage, Nordjylland.

I bilag M listes de 370 sted-art kombinationer for ikke-skovarter sorteret efter Naturstyrelsens enheder og skovnumre og med oplysning om hver arts biotop, økologiske behov og kendte trusler. Oplysningerne er forkortet og harmoniseret, så arterne lettere kan overskues og grupperes, og medtager primært forhold, som er direkte forvaltningsrelevante for Naturstyrelsens arealer. Fx er afvanding og bebyggelse ikke medtaget som trusler, da de ikke er relevante længere grundet styrelsens generelle beskyttelsesregler.

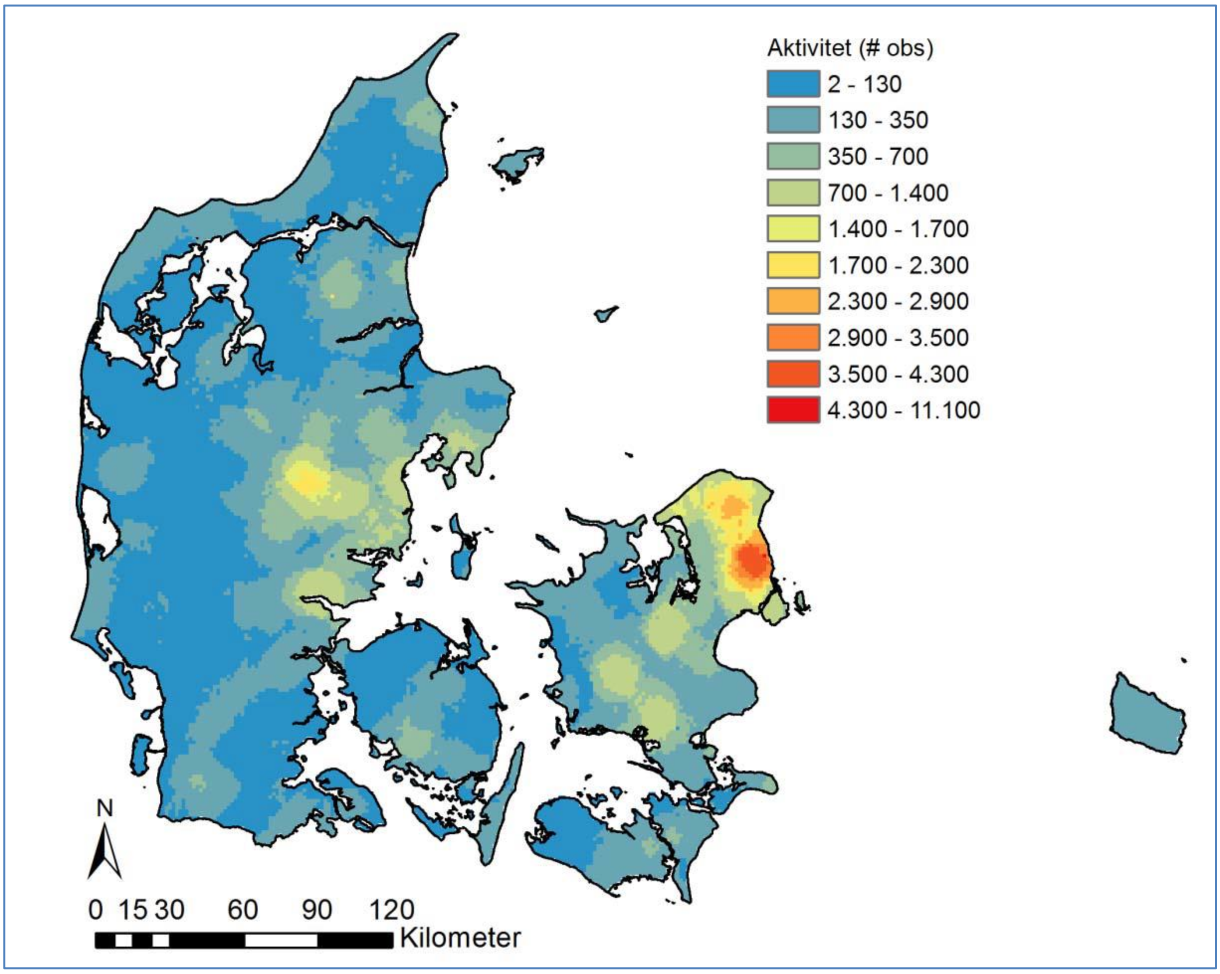
Naturforvaltningen bør målrettes til at sikre levesteder, som matcher arternes biotop og økologiske behov, samtidig med at de for arten angivne trusler begrænses i videst muligt omfang. Klimaforandringer er et eksempel på en for nogle arter afgørende trussel, som ikke kan begrænses lokalt. Hvis biotop og andre økologiske behov optimeres, vil artens overlevelsesmuligheder øges – måske tilstrækkeligt til at kunne klare også klimapresset.

Oversigten for ikke-skovarter blev afleveret elektronisk til Naturstyrelsen i maj 2017 med henblik på at kunne indgå i den løbende planlægning af beskyttelse og forvaltning af arter.

6. Fejlkilder og usikkerheder

Det er vigtigt at notere sig, at data for arterne baseres på registrerede forekomster, dvs. "presence" data - i modsætning til mere optimale "presence-absence" data. Forudsat korrekt artsbestemmelse og kvalitetssikring af tid og sted, kan man regne med artsfundene, men man kan ikke altid vide om manglende angivelse af en art skyldes, at den reelt mangler på lokaliteten, eller om den blot er overset, fx grundet manglende besøg af en relevant artsspecialist på relevant årstid (i faglitteraturen benævnes sådanne manglende registreringer af reelle forekomster som ”false absences”).

Danske data for artsforekomster fra bl.a. citizen science er ikke ligeligt geografisk fordelt, idet der er en signifikant afhængighed af undersøgelsesintensitet, som i høj grad er koblet til bl.a. befolkningstæthed (Bladt et al. 2016, Geldmann et al. 2016). Det gælder også data i nærværende projekt, som må formodes at have tilsvarende skævheder som figur 8, idet der er et stort overlap i datagrundlag til Bladt et al. (2016). Af disse årsager er det i hvert fald for skjult levende og vanskeligt kendelige arter urealistisk at skaffe "presence-absence" data.



Figur 8. Aktivitetsniveau for artsregistreringer baseret på et udtræk af alle artsfund fra Fugle og Natur, Svampeatlas og Danmarks Naturdata (Bladt et al. 2016).

Når arternes forekomstmønster ikke kendes 100 %, bliver de resulterende zone-konstellationer sub-optimale sammenlignet med en teoretisk ideel situation. Et eksempel er den globalt truede bille (*Ampedus hjorti),* som er lille, svær at kende og skjult levende, og dermed kun findes af få specialister. Det gælder tilsvarende en række andre arter, herunder mange lavarter. Falsk manglende tilstedeværelse, "false absence", er en fejlkilde (omission error) for sådanne arter, som det er vanskeligt at kvantificere og håndtere. Derimod blev falsk positive fejl, fx grundet fejl i stedangivelsen, og andre fejl minimeret ved omhyggelig og langvarig kvalitetssikring af data i PhD-projektet ud over dataleverandørernes egenkontrol.

For at minimere fejl af omission error typen blev dataperioden valgt som 25 år 1991-2015, således at den inkluderede de systematiske atlasundersøgelser af sommerfugle og karplanter startet omkring 1991 og alle de efterfølgende atlas-undersøgelser (svampe, fugle, pattedyr, guldsmede mv.). Hvis ingen har registreret en truet art fra en lokalitet i de nævnte 25 år, er der større sandsynlighed for, at lokaliteten ikke er vigtig for arten. De fleste skove helt uden så-danne registreringer er småskove eller ret ung skovrejsning. Selv skove relativt langt fra be-folkningscentre havde ofte mange registreringer. Fx havde Nørlund Plantage i Midtjylland mere end 100 truede arter registreret.

Da Aichis mål 12 omhandler kendte truede arter, og fordi det er svært målrettet eller effektivt at beskytte arters "ukendte" levesteder, vurderedes de anvendte "presence" data generelt for egnede til opgaven med prioritering af lokaliteter. Vurderingen af om en art er i tilbagegang eller ej, som der er fokus på i Aichi målet, baseredes på oplysninger i rødlistedatabasen og kan være af varierende sikkerhed. Dels er den udført af forskellige arts eksperter, dels skønnet over forskellige årrækker fra 10 til 100 år afhængigt af hver arts generationstid, som heller ikke kendes eksakt.

Mangelfuld eller mis-forståelse af arternes økologiske behov, præferencer eller udviklings-tendenser er dermed en potentiel fejlkilde. Den blev minimeret ved at trække på de bedste tilgængelige systematiske database- og litteratur-kilder og ved i processen at konsultere rele-vante artseksperter. Alligevel var der nogle enkelte arter, som tilsyneladende havde andre eller bredere præferencer end de definerede, fx var svampene *Coprinus pannucioides* og *Leu-cocoprinus brebissonii* kendt fra skovrejsningsområdet Vestskoven, men ikke fra nogen urør-te skove, selvom de var forudsat at have behov for zone 4 (Urørt). Denne problemstilling var efter alt at dømme en undtagelse, men kan ikke udelukkes for andre relativt dårligt kendte sjældne arter.

Grundet væsentlig usikkerhed om størrelsen af det økonomiske tab ved beskyttelsestyperne zone 2 (Nål), og zone 3 (Aktiv), blev følsomheden belyst ved at afprøve forskellige kombina-tioner af økonomisk tab. Heldigvis viste scenarierne, at zone-konstellations resultaterne ikke blev påvirket væsentligt af valget af økonomisk tab, idet de forblev konstante over en bred spændvidde af forudsatte tab. Mere detaljeret planlægning for zone 2 og 3 vil være nødvendig skov for skov for at opnå optimal beskyttelse, og hvis der ønskes mere præcise estimater af økonomisk tab.

For yderligere at afprøve i hvor høj grad ovenstående fejlkilder og usikkerheder kunne påvirke resultaterne for især zone 4 (Urørt), udførtes til sidst tre ekstra scenarier Q1, Q2 og Q3 som variation over scenarie Q.

Scenarie Q1 blev begrænset til arter overlappende artsudvalget i Petersen et al. (2016b), idet det artsudvalg blev vurderet som bedst kendt og kortlagt, så der var lavest mulig risiko for effekter af false absences. Kun 115 af de 304 prioritet A arter var medtaget i Petersen et al. (op.cit.) og dermed fælles. Det andet ekstra scenarie, Q2, fik som forudsætning, at alle 304 prioritet A arter ville kunne trives i zone 4 (Urørt), ud over den/de zoner, som arten var henført til i forvejen. Som beskrevet i afsnit 2.5 og 5.2 er der utvivlsomt arter som vil blive negativt påvirket af en overgang til urørt skov i dogmatisk forstand, men scenariet kan kaste lys over i hvilken grad en sådan ændring i forudsætninger kan påvirke resultaterne. Endelig fik varianten Q3 som forudsætning, at alle arter kun havde præference for zone 4 (Urørt), for at kunne vurdere hvor meget omkostningerne påvirkes af zonerings tilgangen.

Scenarie Q1 pegede på 33 statsskove til zone 4 (Urørt) (12.771 skovbevoksede ha) i stedet for de 50 skove med 15.281 ha i scenarie Q (Tabel 13). Scenarie Q1 havde 138 gap-arter, jf. tabel 14, og dermed lav målopfyldelse i relation til de 304 prioriterede arter. Af markante forskelle i valg af skove kan nævnes, at scenarie Q1 i forhold til scenarie Q zone 4 (Urørt) udelod 12 skove helt og skiftede zone for andre ni skove, herunder til zone 3 for de meget artsrige og velundersøgte Møns Klinteskov, Buderupholm Nørreskov, Nørreskoven i Farum og Teglstrup Hegn (Bilag K). I alt 84 scenarie Q skove blev helt udeladt fra scenarie Q1 (dvs. kom i zone 1), fx Kobskov og Østerskov m.fl. ved Silkeborg, Hald Inderø, statsskovene på Nordbornholm, skovene omkring Gurre Sø, Ryget og Charlottenlund Skov. Til gengæld medtog scenarie Q1 følgende syv skove, som ikke var med i scenarie Q: Gilbjerggård (zone 3), Krogenlund (zone 3), Ålbæk Plantage (zone 2), Grishøjgårds Krat (zone 3), Ejerslev Vang (zone 3), Nystrup Plantage vest (zone 2) og Hjardemål Plantage (zone 2) (Bilag K).

Tabel 13. Sammenligning af scenarie Q1, Q2 og Q3 med Q.

Arter			Skove							
Mål nået (af 304 arter)	**Scenarie**	**Antal arter med**	**Tabs forud-sætninger**	**z1 areal %**	**z2 areal %**	**z3 areal %**	**z4 areal %**	**årligt tab %**	**z4 (ha)**	**z4 (n)**
231	Q	304	intermediære	37	20	29	14	46	15.281	50
166	Q1	115	intermediære	57	16	15	12	33	12.771	33
NA	Q2	304	intermediære	47	9	19	25	48	26.119	69
NA	Q3	304	intermediære	47	0	0	54	59	56.679	203

NA = Ikke relevant. z = zone. Ikke angivne forudsætninger er lig scenarie Q (se tabel 3). De 146 skove, som ikke fik ens zone i disse tre scenarier, kan ses i bilag K med arealer og zoner.

Forskellen mellem scenarie Q1 og Q tilskrives især det betydeligt mindre antal arter, som indgik i Q1 optimeringen. Hvis man i stedet ser på om scenarie Q formåede at dække de 115 godt kendte arter fra scenarie Q1, viser tabel 14, at der var 28 gap-arter mod 16 i scenarie Q1. Ingen af scenarierne formåede at få dækket alle de globalt truede arter eller EU-arterne. Hvis man ser nærmere på tallene i tabel 14, fremgår det, at især laver og andre invertebrater får mindsket andelen af gap-arter markant fra scenarie Q1 til Q og dermed repræsenterer noget andet end de arter, der er med i Q1. I hvert fald for laverne giver det god mening, da der er tale om en artsgruppe med komplementære habitatkrav til de fleste andre arter. Det er dog også en gruppe, hvor datadækningen er dårlig. Omvendt er planterne helt ens hvad angår gap-arter i de to scenarier, hvilket viser, at scenarie Q ikke er bedre for planter end Q1.

Tabel 14. Fordelingen af arter og gap-arter i scenarie Q1 i forhold til scenarie Q.

Antal arter	Q	Q1	GapQ-304	GapQ1-304	GapQ-115	GapQ1-115
DK_truet	288	110	69	132	26	16
EU truet	13	5	2	4	2	0
Globalt truet	3	0	2	2	0	0
Pattedyr	4	4	1	0	1	0
Fugle	3	2	0	1	0	0
Padder	3	0	0	1	0	0
Insekter	93	43	29	41	14	7
Andre invertebrater	6	0	2	5	0	0
Svampe	122	59	27	55	10	8
Laver	55	0	6	27	0	0
Mos	1	0	0	0	0	0
Planter	17	7	8	8	3	1
I alt	304	115	73	138	28	16

De første to kolonner viser antallet af prioritet A arter, som hvert scenarie blev optimeret ud fra. De fire højre kolonner viser, hvor mange af de 304 henholdsvis 115 arter, som ikke fik deres behov opfyldt det målsatte antal steder og dermed kaldes Gap-arter. De sammenlagt 155 gap-arter listes i bilag L med detaljer.

Scenarie Q2 pegede på 69 statsskove til zone 4 (Urørt) (26.119 skovbevoksede ha) i stedet for de 50 skove med 15.281 ha, som scenarie Q viste (Tabel 13). Det økonomiske tab var større end for scenarie Q (48,1 % tab mod 46,1 %) og arealbehovet til urørt ca. dobbelt så stort som Naturpakkens ambitionsniveau. I det lys er det kun lidt større indtægtstab overraskende. Forklaringen ses af tabel 13 og bilag K, idet Scenarie Q2 har betydeligt mindre arealer og antal skove i zone 2 og 3 end scenarie Q, hvilket altså er tæt på økonomisk at opveje de større arealer i zone 4.

Scenarie Q3 varianten, hvor beskyttelse kun var mulig i zone 4 (simulerende ingen zonering), henførte 203 skove til beskyttelse med et tab på 58,9 % af årlig netto indkomst fra høst af træ, sammenlignet med 46,1% for scenarie Q (Tabel 13). Besparelsen ved zonering svarer dermed til 21,7 % i forhold til, hvis al beskyttelse skulle ske som urørt skov. Hvis de billigere omkostnings forudsætninger i scenarie U og Y for zone 2 og 3 er mulige at realisere, vil besparelsen blive proportionalt højere.

Scenarie Q2 og Q3 havde ingen gap-arter, men det bør ikke tillægges vægt, idet de to varianter som nævnt fik som bunden forudsætning, at alle arter kunne trives i zone 4 (Urørt) uanset viden om at dette næppe er tilfældet under de aktuelle forudsætninger. De fleste af scenarie Q2's ekstra 19 skove i zone 4 (Urørt) kendetegnes da også af arter og biotoper, som ikke normalt forbindes med urørt løvskov, fx plantagerne Hoverdal, Fejsø, Vilsbøl, Rø og Hornbæk, foruden Hanstholm Kystskrænt, Mols Bjerge, Markerne ved Kalø, Ølene og Vestamager.

Scenarie Q1, Q2 og Q3 viste ikke overraskende, at resultaterne påvirkes af hvor mange arter, der indgår, og hvilke præferencer, de tillægges, men ændrede ikke på vurderingen af, at scenarie Q havde de mest relevante forudsætninger og resultater.

7. Anbefalinger om indsatsen i skov

Der er i den videnskabelige litteratur undersøgt mange indsatser, som kan bidrage til beskyttelse af biodiversiteten i skov (review i Bernes et al. 2015), herunder mange anbefalinger af at udlægge mere skov som urørt skov eller anden biodiversitetsskov, samt generelt øge mængden af dødt ved. Hvilken type dødt ved, der er tale om, kan være afgørende og meget artsafhængigt (Heilmann-Clausen & Aude 2006, Heilmann-Clausen & Christensen 2003 & 2004, Heilmann-Clausen et al. 2014, Stokland et al. 2012).

På baggrund af den gennemgåede litteratur suppleret med upublicerede erfaringer fra udmøntningen af Naturskovsstrategien i 1990'erne, samt nærværende projekts omfattende granskning af truede arters forekomst, økologiske behov og præferencer, gives i det følgende nogle overordnede anbefalinger for indsats i overgangsperioden og for anden biodiversitetsskov. Der er tale om forfatternes originale syntese af det samlede arbejde, og der gives derfor ikke særskilte litteraturreferencer.

Anbefalingerne tager udgangspunkt i, at formålet er at standse tilbagegangen i biodiversitet, jf. de nationale og internationale politiske aftaler herom. Der tages desuden udgangspunkt i den økonomiske forudsætning i Naturpakken, at der skal fældes og sælges en betydelig mængde træ fra skovene, inden de overgår til urørt status. Naturstyrelsen har endvidere bestilt en særskilt rapport, som skal komme med yderligere anbefalinger til indsatsen, og som selvfølgelig anbefales konsulteret, når den kommer.

Med regeringens Naturpakke er der besluttet en meget væsentlig forøgelse af arealet af dansk skov beskyttet af hensyn til biodiversitet. Placeringen af de ny beskyttede skove anbefales fastlagt på baggrund ikke kun af analyserne i nærværende projekt, men også under hensyntagen til bl.a. øvrige analyser leveret af Aarhus og Københavns Universiteter, samt til kulturhistoriske, friluftsmæssige og økonomiske værdier. Nærværende analyser bør nemlig ikke opfattes som et facit, men som input til beslutnings støtte.

I lyset af at Naturpakkens ambitionsniveau med hensyn til urørt skov passer godt til resultaterne af scenarie Q i nærværende projekt, mens niveauet for anden biodiversitetsskov arealmæssigt er lavere end summen af zone 2 og 3, anbefales det, at hensynene til truede arter med præference for nål eller lysåbne forhold indarbejdes i Naturstyrelsens almindelige beskyttelsesindsats i det omfang, arealerne ikke udpeges som anden biodiversitetsskov. En lang række af arterne findes allerede i generelt beskyttede delarealer i skovene eller er tilknyttet nåletræer, således at de vurderes mange steder at kunne beskyttes i den almindelige arealforvaltning.

For ny urørt løvskov er der i Naturpakken fastsat en overgangsperiode på 10 år inden urørt status, for nåletræsplantager en overgangsperiode på 50 år, mens løbende indsatser kan foregå i anden biodiversitetsskov. Det bliver dermed afgørende, hvordan den konkrete praktiske forvaltningsindsats implementeres i henholdsvis overgangsperioden og efterfølgende.

7.1 Indsats i overgangsperioden og i anden biodiversitetsskov

Målret indsatsen til stedets truede arter eller artsgrupper og deres præferencer. Da arterne har forskellige økologiske behov betyder det, at der kan være variation i tilgangen. På steder med arter med behov for dødt ved bør mængden af dødt ved fx øges, således at mere træ forbliver i skoven som dødt ved, og mindre træ sælges. I gamle skovbevoksninger med dødtveds afhængige arter bør hugst undlades eller holdes på et minimum. I skove med arter, der behøver skovlysninger, fx truede sommerfugle, bør modsætningsvis større områder i skoven konverteres til lysninger, fx ved fældning og fjernelse af monotone forstlige yngre træbestande.

En væsentlig del af skovarterne trives bedst eller kun i skovlysninger eller i *bløde overgange* mellem skov og helt lysåbne biotoper. Den menneskeskabte opdeling mellem skov og lysåbne biotoper i landskab og forvaltning er uheldig for mange arter og bør modvirkes ved i videst muligt omfang at samtænke forvaltning af skov med lysåbne biotoper. Det kan fx ske ved samgræsning af større områder, som rummer både træbevoksede og lysåbne arealer.

Græsning er en essentiel funktion for økosystemet og for mange af de truede arter. Det anbefales i videst muligt omfang at etablere eller videreføre naturlige græsningsniveauer i biodiversitetsskovene. Her er det vigtigt at notere at et hårdt græsningstryk i sommerhalvåret kan være ligeså skadeligt som mangel på græsning for bl.a. truede sommerfugle. Som udgangspunkt anbefales et ret lavt helårs græsningstryk i stil med det i Tofte Skov (Lille Vildmose) idet undersøgelser tyder på, at det er noget af det nærmeste, man i Danmark kommer et naturligt græsningstryk, og det giver en god balance mellem træer/skov og lysåbne biotoper, samtidig med gode forhold for en meget lang række truede dyr og planter. Se også afsnit 8.3 for mere om græsning.

Kontinuitet i tid og rum er tilsvarende meget vigtig. Dvs. at skovpartier med meget høje naturværdier som udgangspunkt bør videreføres uden væsentlig hugst eller andre store forandringer (bortset evt. fra mere naturvenlig græsning), idet den hidtidige forvaltning åbenbart har været god for arterne. For at skabe større kontinuitet i rum anbefales sådanne hotspots understøttet ved at skabe grundlag for udvikling af tilsvarende kvaliteter på tilgrænsende arealer, så det samlede areal med god kvalitet øges.

En række undersøgelser har efterhånden påvist den store naturværdi ved genskabelse af mere naturlige vandforhold i skove, så genopretning af *hydrologien* ved lukning af grøfter (også dem, som ser tørre ud det meste af tiden) bør gennemføres konsekvent og effektivt. Vådere forhold og større sæsonudsving i vandstand er meget vigtige for en lang række truede arter, og medvirker desuden til mere lys og større variation i skoven og til mere dødt ved.

Det bør som udgangspunkt tilstræbes at skabe eller øge skovens *strukturelle variation*, både i stor og lille skala, dvs. skabe variation på skov- og bevoksningsniveau i træartssammensætning, tæthed og aldre. Især i stærkt forstligt prægede bevoksninger bør der føres en meget markant anderledes hugst end normalt ved at modvirke den homogenisering, som den forstlige praksis har medført. Sørg fx for plads nok til at enkelttræer og trægrupper kan vokse frit og udvikle store grovgrenede kroner under lysstillede forhold. Skab større lysbrønde (diameter større end træhøjde) i ensartede bevoksninger, for at skabe et mere varieret grundlag for fremtidig dynamisk og strukturel udvikling. Undlad udtynding i andre partier for at skabe fremtidens tykninger. Undlad at hugge afvigerne i en bevoksning, dvs. værn om de største og de mindste træer, samt de træ- og buskarter, som der i den konkrete bevoksning er få af.

Fremme af *dødt ved* i skoven kan generelt anbefales, men undersøgelser har vist, at det især er levende træer med dødt ved og/eller hulheder, samt selvdøde træer knækket ved roden, som huser truede arter. Kunstigt frembragt dødt træ ved hjælp af fx motorsav eller ringbarkning er tilsyneladende ikke et ligeså gunstigt substrat for truede arter, men erfaringsgrundlaget er beskedent. Kunstigt frembragte hulheder eller brandskader på levende træer har dog vist sig at tiltrække rødlistearter.

Ved hugsten bør de *træer skånes*, som har flest synlige skader, bugtninger, grove grene eller lignende, idet det giver biologisk værdi eller potentiale. Til gengæld kan hugsten fint udtage økonomisk værdifulde træer, idet disse typisk har mindre biologisk værdi ved at være fri for huller, råd og store knaster mv. De største / ældste træer i hver bevoksning bør skånes for hugst og bevares som *Livstræer*. *Gamle ege*, som presses af nabokonkurrence fra fx bøg, bør hjælpes fri af konkurrencen ved fx hugst eller ringbarkning af nabotræerne, idet gamle ege kan have stor biodiversitets betydning, men alt for ofte dør i konkurrencen med nabotræer.

Generelt bør indsatsen værne om og fremme *buske* og *lyskrævende træer*, som har stor betydning for biodiversiteten, men har langt mindre udbredelse i moderne skove, end de havde i historiske og forhistoriske mere naturlige skove. Det gælder ikke mindst insektbestøvede arter og pionertræarter som asp, birk, eg, pil og skovfyr. Asp har i modsætning til de andre nævnte en relativt dårlig koloniseringsevne og var stærkt forfulgt i meget lang tid, så den er tæt på udryddet i mange skove. Det kan overvejes at udbrede den til mange flere steder, fx ved udplantninger eller stiklinger med lokalt / regionalt materiale.

Bevoksninger med træarter fra *fremmede* kontinenter har normalt lav værdi for biodiversiteten, især hvis de tilhører slægter, der ikke findes i Europa, men kan have stor økonomisk værdi. Hvis ikke der er særlige artsforekomster, som kan begrunde andet, anbefales sådanne bevoksninger afviklet i overgangsperioden, så arealet kan overgå til urørt naturlig tilgroning, hvilket som regel i kortere eller længere tid vil skabe en skovlysning, og derefter en blandet skov af selvsåede træer og buske. Eksempler på sådanne *fremmede træarter* er rødeg, robinie, sitkagran, douglasgran, grandis og thuja.

Bevoksninger med *træarter fra Europa* har normalt større værdi for biodiversiteten og bør vurderes konkret i forhold til deres betydning for stedets truede arter. Da 110 af de 626 truede skovarter har præference for *nåletræer*, og en række af de øvrige arter trives med blandet løv-nål skov, er der basis for at opretholde et vist kontingent af europæiske nåletræer i skovene - ikke mindst skovfyr og rødgran, men også lærk, ædelgran og bjergfyr har tilknyttede truede arter. Massive plantede bevoksninger af rødgran bør vurderes konkret i forhold til skovens truede arter, idet visse arter har glæde af renafdriftsrydninger efter gran, mens andre arter, fx den globalt truede blank gæstemyre, har behov for tuer af rød skovmyre, som typisk trives godt ved udkanten af granskov og måske forsvinder, hvis granskoven ryddes.

Generelt anbefales et *europæisk biogeografisk perspektiv* i lyset af, at arterne ikke respekterer politiske landegrænser og ikke har nået at udfylde deres potentielle naturlige udbredelser efter istiden. Arternes indvandring til Danmark sydfra var en igangværende dynamisk proces også før de tiltagende klimaændringer, men er accelererende. Etablering og udbredelse af europæiske arter bør derfor ikke opfattes som et invasivt problem i skovene, men som at arterne er i proces med *klimatilpasning*.

Som følge af de accelererende *klimaændringer* er det sandsynligt, at visse arter især med nordlig eller kontinental hovedudbredelse går tilbage eller ligefrem forsvinder fra Danmark. Det anbefales at prioritere konkret indsats for sådanne klimamæssigt marginale arter lavere end for andre truede arter, hvis de vides at være talrige og udbredte i nabolande mod nord og øst.

En mindre del af de truede arter har behov for *brand* i form af brændt træ eller brandpletter efter kvasbrænding. Generelt er brand og ild i skoven blevet meget sjældnere end i mange tusinde år. Øget anvendelse og accept af ild og brand anbefales derfor på steder og i et omfang, som ikke medfører sikkerheds risici, fx ved anvendelse af små bål ved foden af enkelttræer for at give dem brandskade (simulerende bundbrand) og ved genoptagelse af afbrænding af kvasbunker på afdrifter i et vist omfang. Brand har antageligt også et stort potentiale som forvaltningsværktøj i overgange mellem skov og åbent land, hvilket bør undersøges nærmere.

For enkelte arter, fx billen eremit (*Osmoderma eremita*) vides det med sikkerhed, at *spredningsevnen* er ekstremt lille i forhold til *isoleringsgraden* af eksisterende forekomster. Risikoen for at *indavl* eller tilfældige faktorer i sådanne tilfælde ødelægger mulighederne for langsigtet overlevelse er overhængende. For sådanne arter bør indsatsen tage udgangspunkt i de bestande og meta-populationer, der umiddelbart har størst levedygtighed, hvilket kan omfatte undersøgelser af graden af indavl. Derudover kan man undersøge mulighederne for kunstig udveksling af individer mellem forskellige forekomststeder under kontrollerede forhold.

7.2 Urørt skov efter overgangsperioden

Det anbefales, at de ny urørte skove efter overgangsperioden ikke forvaltes dogmatisk som fuldstændig urørte. Der kan dels være behov for indgreb for at sikre passende græsning, dels indgreb af hensyn til at afværge trusler fra fx invasive arter eller for at medvirke til gunstig bevaringstilstand for Natura 2000-arter eller -naturtyper. I tilfælde, hvor der er behov for andre aktive forvaltningstiltag end rent sikkerheds betingede tiltag, anbefales en plan for indsatsen fastlagt, fx som driftsplantillæg.

Det afgørende bør derefter være, at de udpegede arealers *formål* fremadrettet er fremme og sikring af biodiversitet. Status som urørt skov kan ses som et middel til fremme af formålet ved at give plads og mulighed for at de økologiske naturlige processer og funktioner kan udfolde sig frit. De udpegede arealer kan således med andre ord og for at svare mere til international terminologi opfattes som biodiversitets-reservater uden adgangsbegrænsning for publikum, men i øvrigt af den internationale type "minimum-intervention".

Det skal i den sammenhæng fremhæves, at kombinationen af urørt skov og græsning, eller med andre ord urørt græsningsskov, generelt bør fremmes, idet det vurderes som den mest effektive måde at genoprette de relevante økosystemprocesser og funktioner, som har betydning for mange truede arters overlevelse og trivsel. Hvis den urørte skov er stor og både indeholder nåletræer, løvtræer, lysåbne biotoper og forvaltes med ekstensiv naturvenlig græsning, vil det potentielt være muligt at tilgodese langt de fleste truede (og almindeligere) arters præferencer og behov indenfor området. Et godt eksempel er Tofte Skov området i Lille Vildmose, men også en række andre gamle dyrehaver har store kvaliteter. Tidsfaktoren og arealskala er i den sammenhæng vigtige.

8. Anbefalede indsatser for lysåbne biotopers arter

Som nævnt i afsnit 5.5 listes de mere eller mindre ubeskyttede forekomster af arter i prioritetsklasse 1 til 3 i bilag M, men også på beskyttede steder kan indsatsen for truede arter i en del tilfælde forbedres. Generelt vil arter i prioritetsklasse 1 og 2 være vigtigere end de øvrige arter i relation til 2020-målene. De 33 ikke-skovlevende arter i prioritetsklasse 1 og 2 listes derfor i bilag N. Forekomststeder hos Naturstyrelsen for disse arter, som ikke er med i bilag M, er allerede underlagt en eller anden form for beskyttelse og forvaltning. Det anbefales lokalt at tjekke, at forvaltningen særligt sikrer gode økologiske forhold for de nævnte 33 arter og justere indsatsen, hvis det ikke er tilfældet. Tilsvarende gælder de i 2020-sammenhæng lidt lavere prioriterede 277 dansk truede ikke-skovarter (prioritetsklasse 3). Allerede mere eller mindre beskyttede forekomster af dem fremgår af de digitale data, som leveredes til Naturstyrelsen som et delresultat af PhD-projektet. Det store antal arter kan gøre det vanskeligt at overskue på landsplan, men for den enkelte skov er antallet af arter typisk lavt, så indsats kan tilrettelægges målrettet.

Med hensyn til detaljerede anbefalinger til indsats og driftsformer kan især følgende grundige og brede sammenstillinger anbefales, idet de også uddyber og giver dokumentation for indsatserne: Bunzel-Drüke et al. (2008), Buttenschøn (2007), Damgaard et al. (2007) og Fløjgaard et al. (2017), samt for heder og klitter Stenild et al. (2016). I det følgende gennemgås nogle af de vigtigste forhold og anbefalinger.

8.1 Supplerende oplysninger

Som følge af det store antal arter, som er truet på landsplan, er det ikke muligt at gå i større detaljer i nærværende rapport. På lokalt niveau for den enkelte skov vil artsantallet være meget lavere, så Naturstyrelsens lokale enhed kan og bør søge supplerende mere detaljeret information om de enkelte arters økologiske behov, om truslerne, og hvordan de bedst kan afhjælpes. For langt de fleste arter er en del oplysninger fx tilgængelige ved at klikke sig frem til den relevante art i den elektroniske rødliste på nettet: http://bios.au.dk/videnudveksling/til-jagt-og-vildtinteresserede/redlistframe/artsgrupper/ . For hver art findes i rødlisten også henvisninger til yderligere kilder og litteratur. Samarbejde med vidende lokale arts entusiaster og naturforeninger anbefales også, da det i mange tilfælde kan bidrage med vigtige oplysninger om arternes lokale status og udviklingstendenser. Endelig kan mange oplysninger findes i online databaserne listet i bilag A.

8.2 Justeret drift og forvaltning

I mange tilfælde vil den nødvendige forvaltning bestå i fortsættelse af hidtidig ekstensiv græsning, slæt, afbrænding eller anden form for indsats, som har opretholdt de lysåbne biotoper mere eller mindre næringsfattige og forhindret tilgroning. De angivne arter er dog truede i et omfang, som viser, at de generelt ikke trives med standard drift, som fx slåning (uden fjernelse af materiale). Slåning er naturmæssigt betydeligt ringere end slæt (hvor materialet fjernes) for i hvert fald en række blomsterplanter, dagsommerfugle og andre insekter, bl.a. fordi materialefjernelse sørger for tilpas næringsfattige forhold og modvirker landskabets generelle eutrofiering (Buttenschøn 2007, Damgaard et al. 2007, Hartvig 2015, Stoltze 2005), jf. afsnit 2.5.

Arealet af bløde *overgange* mellem skov og lysåbne biotoper blev, jf. afsnit 2.5 og 3.4, stærkt formindsket gennem 1800-tallet og er fortsat meget lavt til skade for en række truede arter, som trives sådanne steder (Buchwald 2012, Bunzel-Drüke et al. 2008, Baagøe & Jensen 2007, EEA 2013, EIONET 2013b, Hartvig 2015, Stoltze 2005, Søgaard & Asferg 2007, Wind & Pihl 2010). Samgræs derfor så vidt muligt skov og lysninger. Opblød skovbryns skarpe linjer. Også på andre måder er *variation* i drift og arealer gået fra småskala til storskala ved ensartet drift af store flader, bl.a. gennem dræning, jordbearbejdning, og i nogle tilfælde ens naturpleje af store områder, fx kratrydning på heder, græsland og kær. På steder med truede insekter vil fremme af småskala variation typisk være en forbedring. Lad fx hjørner og kanter afvige og undlad at græsse/slå/brænde/hugge 100 % af litra/afdeling.

Kontinuitet i tid og rum er meget vigtig for mange arter (Nordén et al. 2014). Det indebærer videreførelse af de forhold, som har gjort det muligt for arten at leve på stedet, foruden at opretholde tilstrækkelig store levesteder og spredningsmuligheder. Brud på kontinuitet, fx ophør af græsning eller slæt, kan i løbet af kort tid (ofte et par år) føre til lokal uddøen af truede arter. Såfremt data viser stabil eller stigende lokal bestand, og driften har været stabil i en årrække, vil det som udgangspunkt være bedst at videreføre den hidtidige drift uforandret. Forbedring kan sådanne steder gennemføres ved udvidelse med egnede arealer i nærheden.

I det følgende gives yderligere kommentarer til nogle af de mest relevante indsatser, som kan bruges til at forbedre eller opretholde levestederne, hvis der er tegn i data på, at den hidtidige indsats ikke har formået at opretholde en stabil eller stigende lokal bestand. Det er forsøgt at uddrage den mest forvaltnings relevante essens af tilgængelige kilder. Indsatsen bør i videst muligt omfang ses i sammenhæng med skovindsatsen, så der opnås en mere holistisk tilgang.

8.3 Græsning

Ekstensiv græsning er en meget vigtig indsats, og bør så vidt muligt baseres på at genskabe naturlige dynamikker og funktioner af græsning, men især hvis arealerne er små, kan det være vanskeligt at gennemføre i praksis (Assmann & Falke 1997, Bokdam & Gleichman 2000, Buchwald 2012, Bunzel-Drüke et al. 2008, Buttenschøn 2007, Baagøe & Jensen 2007, EIONET 2013a, EIONET 2013b, Fløjgaard et al. 2017, Fredshavn et al. 2014, Hartvig 2015, Maroo & Yalden 2000, Nielsen 2009, Nielsen & Buchwald 2010, Vikstrøm et al. 2015, Wind & Pihl 2010, Wind & Ejrnæs 2014). Oftest tåler de truede arter ikke den form for græsning, som praktiseres med EU-tilskud, idet den typisk er for intensiv. En mere naturvenlig og svag græsning er nødvendig ikke mindst på levesteder for de truede sommerfugle (og en række andre arter). Der er for mange eksempler på lokal uddøen som følge af for hård græsning, som i landbrugstilskuds optik i hvert fald tidligere har været "normal græsning". Disse arter forsvinder længe før arealet er græsset i bund. Der behøves et mere naturligt og dynamisk græsningstryk, som tillader/udvikler et rigt blomsterflor af mange blomstrende arter hen over sæsonen. Et tegn på succes er at væsentlige dele af græsgangen ser "pelset" eller "langhåret" ud gennem sæsonen og at der efterlades vinterstandere af diverse urter.

Ekstensiv helårsgræsning og samgræsning af flere slags dyr anses ofte for bedst for naturkvaliteten knyttet til lysåbne arealer, men det er vigtigt for de fleste truede arter at undgå hård græsning, som nemt bliver resultatet bl.a. i det tidlige forår, hvis arealerne er små eller dyretætheden for stor. Græsning kombineres ofte med tidvis hugst af dele af træ- og busk opvæksten, så der opretholdes et mix af småkrat og træer i græsgangen uden at vedplanterne tager overhånd. Vedplanterne har mange positive natureffekter, og bør derfor for at undgå kontinuitetsbrud normalt ikke ryddes længere ned end til fx 10 % dækning af arealet, hvis der er tradition for, at der har været vedplanter i græsgangen.

Heste, køer, hjortedyr, geder og bison er udmærkede forudsat passende lavt græsningstryk. Får anses normalt for mindre egnede til naturpleje, idet de spiser blomsterne før græsset, så mængden af blomster falder. Ekskrementer fra græsningsdyr er af essentiel betydning for flere af de truede arter – ofte arter med "møg" eller "gødning" i navnet. På steder, hvor sådanne arter lever, er det således afgørende ikke at afbryde græsningen et år, ligesom helårsgræsning kan være essentiel. Tilsvarende er der en række medikamenter som husdyrene ikke bør få, da de gør ekskrementerne golde eller giftige for insekterne (Bunzel-Drüke et al. 2008, Wind & Pihl 2010).

8.4 Høslæt

Traditionel høslæt var igennem århundreder overordentligt udbredt i landskabet (inklusive skovene) og har spillet en stor rolle for visse lavtvoksende karplanter og ikke mindst dagsommerfugles store hyppighed, indtil høslæt efterhånden nærmest ophørte i årene efter 1950 (Buchwald & Vikstrøm 1991, Buttenschøn 2007, Hansen & Vikstrøm 2005, Hartvig 2015, Jørgensen 2005). En effekt af høslæt var skabelsen og opretholdelsen af næringsfattige blomsterrige arealer med meget lav forstyrrelse gennem forår og forsommer indtil selve slættet. Årligt slæt fjerner store konkurrencestærke plantearter, dels omkring 100 kg N/ha/år, hvilket er 5–10 gange mere end eutrofieringen fra atmosfæren, så der skabes næringsfattige lysåbne forhold, hvilket mange truede arter har behov for (Damgaard et al. 2007, Hicks et al. 2011, Stenild et al. 2016).

Sammen med småskalavariation i det gamle landbrugslandskab med mindre græsningsfolde og små agre gav det gode levesteder for mange arter. På steder med truede arter af perlemorsommerfugle, blåfugle, pletvinger eller køllesværmere vil det være vigtigt for redning af faldende bestande at sikre et tilsvarende mix af forskellige successionsstadier og driftstyper med ikke for store flader behandlet intensivt samtidig (EEA 2013, Eskildsen 2015, Eskildsen et al.

2015, Stoltze 2005). Bestanden kan uddø, hvis hele dens areal i løbet af kort tid gives samme behandling, hvis behandlingen fx er intensiv græsning eller afbrænding (Wind & Ejrnæs 2014, Wind & Pihl 2010) og det er endnu uvist om ekstensiv helårsgræsning på kort sigt kan opretholde passende levesteder, hvis udgangspunktet er det nuværende kulturlandskab. Høslæt bør af ovenstående årsager ikke høste det samlede areal af en eng indenfor samme uger, når bestandsbevarelse er formålet. Opdeling på et eller flere delarealer med tidligt slæt (typisk 2. halvdel af juni) og andre arealer med sent slæt (august – september) kan være en løsning eller kombination med efterladen af mindre dele uslået visse år. Ifølge samtaler med gamle bønder (Buchwald upubl., Jørgensen 2005) startede det traditionelle høslæt i tiden omkring Skt. Hans og fortsatte i mindst 7 uger af sommeren for at nå ud til alle engene.

I gamle dage var der derfor gennem hele sommeren enge i forskellige faser af modning og genvækst, hvilket har været gavnligt for bl.a. sommerfugle (Stoltze 2005). Maskinelt slæt i en bræmme langs skovveje og stier kan være en relativt billig og effektiv måde til at opnå både levesteder og spredningsveje for truede planter, sommerfugle og andre arter (Jørgensen & Karlog 2005).

8.5 Andre indsatser

Afbrænding fjerner ligesom høslæt meget kvælstof og andre næringsstoffer og medvirker derfor til næringsfattige forhold (Damgaard et al. 2007, Hicks et al. 2011, Stenild et al. 2016). Samtidig øger det pH og kan fjerne et litter / humuslag, samt fremme pyrofile arter. Hede eller hedeagtige biotoper blev i urskovstiden skabt af brande (Odgaard 1994). Den mest naturlige hedepleje er derfor brand, men naturbrand forekom også i andre naturtyper. Visse specielle insekter og svampe er tilpasset til det og kan finde frem på lang afstand (Wind & Pihl 2010). Det kan derfor være godt for en række arter at brænde arealer eller kvas med jævne mellemrum. Også træer såret af brand kan tiltrække særlige truede arter, hvilket bl.a. er set ved igangværende forsøg i Gribskov, hvor små bål blev tændt ved foden af bøgetræer (egne upubl. undersøgelser).

En række af de truede arter er tilknyttet vandhuller og andre typer af *småvande*. Danmark mistede en meget stor del af sine vandhuller og småvande mellem 1945 og 1990, og i den forbindelse forsvandt op til 90 % af levestederne for de mest truede paddearter (Fog 1993). Et par årtiers naturgenopretning af småvande har vist, at truede arter som padder og guldsmede hurtigt gavnes af ny vandhuller. Naturstyrelsens løbende indsats for naturlig hydrologi og ny søer er derfor vigtig at holde fast i og videreføre. I den forbindelse er genskabelse af naturlige udsving i vandstand meget vigtig, idet en række af de mest truede arter netop er afhængige af vandstandssvingninger og den tidvis oversvømmede zone (EIONET 2013b, Fredshavn et al. 2014, Hartvig 2015, Søgaard & Asferg 2007, Vikstrøm et al. 2015, Wind & Pihl 2010).

Skovene har desuden relativt få *insektbestøvede* træer og buske i dag. Forvaltningen bør derfor så vidt muligt fremme buske og træer med blomster til insekter (Buchwald 2012, Bunzel-Drüke et al. 2008, Wind & Pihl 2010).

8.6 Økonomi

Det har ikke været muligt at beregne konkret økonomi på enkelte indsatser, da de lokale forhold er for forskellige. Omkostningerne er derfor tilsvarende variable, bl.a. som følge af forskelle i arealstørrelse, driftsform og naturtype, jf. tabel 15, som stammer fra den nyeste grundige analyse af emnet.

Tabel 15. Oversigt over driftsøkonomiske omkostninger (netto) ved plejeformer på naturarealer uden tilskud, kr./ha i 2009 prisniveau (fra Dubgaard et al. 2012). Bemærk den store afhængighed af arealstørrelse.

	Slæt	Stude	Ammekvæg, hårdføre	Ammekvæg vækst	Natur-kvæg	Får
Fersk eng						
< 20 graders hældning						
3 ha	-1.445	-6.869	-7.941	-6.691	-2.277	-6.235
6,5 ha	-1.172	-6.297	-7.369	-6.119	-1.705	-5.533
15 ha	-900	-5.812	-6.884	-5.634	-1.250	-4.992
Overdrev						
< 20 graders hældning						
3 ha	-1.526	-4.532	-4.775	-4.271	-1.945	-4.059
6,5 ha	-1.253	-3.951	-4.203	-3.699	-1.373	-2.964
15 ha	-981	-3.475	-3.718	-3.213	-888	-2.817
> 20 graders hældning						
3 ha	-	-4.717	-4.960	-4.455	-2.130	-4.244
6,5 ha	-	-4.145	-4.388	-3.884	-1.558	-3.542
15 ha	-	-3.660	-3.903	-3.398	-1.073	-3.001
Strandeng						
< 20 graders hældning						
3 ha	-1.553	-3.585	-3.726	-3.380	-1.821	-3.304
6,5 ha	-1.280	-3.011	-3.152	-2.806	-1.247	-2.600
15 ha	-1.008	-2.516	-2.657	-2.311	-753	-2.050
Mose						
< 20 graders hældning						
3 ha	-	-2.560	-2.660	-2.841	-1.752	-2.639
6,5 ha	-	-1.988	-2.088	-1.835	-1.181	-1.891
15 ha	-	-1.503	-1.603	-1.350	-695	-1.351
Hede						
< 20 graders hældning						
3 ha	-1.580	-2.375	-2.475	-2.292	-1.568	-2.454
6,5 ha	-1.307	-1.803	-1.903	-1.721	-996	-1.707
15 ha	-1.035	-1.318	-1.418	-1.235	-510	-1.166
> 20 graders hældning						
3 ha	-	-2.560	-2.660	-2.477	-1.752	-2.594
6,5 ha	-	-1.226	-1.562	-1.150	-1.181	-1.423
15 ha	-	-1.503	-1.603	-1.420	-695	-1.351

Slæt henholdsvis græsning med "naturkvæg" (helårs ekstensiv) er de billigste af de alternativer, som blev undersøgt af Dubgaard et al. (2012), og det er samtidig dem, der som nævnt er mest hensigtsmæssige for truede arter. Dubgaard et al. (op.cit.) fandt desuden, at græsning med lavt græsningstryk generelt var billigere pr. hektar end normalt græsningstryk. Tilsvarende forskningsbaserede tal for økonomien i brandpleje er ikke fundet, men afbrænding af hede anses for en "ret billig plejemetode" (Miljøstyrelsen 2017). Erfaringstal for udgifterne til afbrænding af hede ligger på mellem 700-3.000 kr./ha afhængig af arealstørrelser og mandskabsforbrug (Stenild et al. 2016).

Det spiller desuden en væsentlig rolle, om det er muligt at oppebære tilskud til indsatsen eller ej. Landbrugstilskud er normalt ikke muligt for lynghede eller for småarealer under 2 hektar, men i øvrigt ofte muligt for lysåbne arealer som eng, strandeng, overdrev og lignende. Ordningerne for landbrugstilskud ændres jævnligt, herunder i hvilket omfang der kan opnås tilskud for Naturstyrelsens arealer. Tabel 16 viser størrelsen af tilskud til slæt og græsning under ordningen "Pleje af græs- og naturarealer" (status 2017).

Tabel 16. Tilskudssatser til slæt og græsning under ordningen "Pleje af græs- og naturarealer", Landbrugs- og Fiskeristyrelsen (2017).

Tilskud der kombineres med grundbetaling (tilsagnstype 67)	**Kr/ha/år**
Pleje med afgræsning	1.650
Pleje med slæt	850
Tilskud der ikke kombineres med grundbetaling (tilsagnstype 66)	
Pleje med afgræsning	2.600
Pleje med slæt	1.050

Inklusive tilskud kan standarddriften på visse større arealer balancere eller give et lille overskud ved naturkvæg eller slæt, mens andre især mindre arealer giver underskud.

Det skønnes, at de særlige økologiske behov for de prioriterede truede arter vil medføre behov for meromkostninger i forhold til standardtallene i tabel 15, og at en del af arealerne vil være for små til at være berettigede til landbrugstilskud. Derfor vurderes der for stederne i bilag M at være behov for en noget højere hektaromkostning på skønsvis det dobbelte af de forskningsbaserede standardtal for slæt og naturkvæg, som er de driftsformer, som passer bedst med de økologiske behov for flertallet af truede arter. Hvis det er muligt at gennemføre driften sammen med tilgrænsende arealer eller på store sammenhængende områder, kan omkostningerne dog nedbringes pr hektar.

9. Konklusion

Det viste sig nødvendigt at behandle skovarter og ikke-skovarter hver for sig, selvom det ikke er optimalt, idet der er en stor gråzone med overlap. Primær årsag var forskel i tilgængelighed af relevante økonomi data sammenholdt med opdelinger på skov og lysåben natur i ikke mindst lovgivning og politiske beslutninger.

9.1 Skove og skovarter

Beslutningsstøtteværktøjet *Marxan with Zones* viste sig som et godt, men stærkt datakrævende, redskab til på omkostningseffektiv vis at pege på forskellige løsningsmuligheder for udpegning af ny beskyttede skove. Med 976 statsskovs arealer og 626 forekommende 2020-måls skovarter var det urealistisk at opnå omkostnings optimering af valget af beskyttede skove på andre måder.

De mest optimale af de 26 løsningsforslag fra Marxan analyserne pegede på et arealbehov for urørt skov, som ikke afveg væsentligt fra ambitionsniveauet i regeringens Naturpakke fra maj 2016, der besluttede at udpege 10.000 ha ny urørt skov i statsskovene. På den anden side viste analyserne, at der kan være større behov for andre typer ny biodiversitetsskove end de 3.300 ha anden biodiversitetsskov besluttet i Naturpakken. En meget stor del af arealerne med 2020-måls-arter, som analyserne foreslog til andet end urørt, er dog allerede beskyttet som § 3-biotoper eller på anden vis, eller er baseret på arter med behov for nåleskov, som bør kunne tilgodeses i Naturstyrelsens drift uden nødvendigvis at blive kategoriseret som anden biodiversitetsskov.

Marxan resultaterne kan yderligere optimeres ved for en mindre del af den optimale Marxan løsnings 233 skove at gennemføre forskellig beskyttelse i forskellige dele af skoven baseret på placering og økologiske behov for skovens 2020-måls-arter. Ved fuld anvendelse af opdelt beskyttelse i omkring 40 statsskove kan alle de 304 prioriterede 2020-måls-arter fx "få det som de helst vil have det" i mindst 5 statsskove eller samtlige statsskove de findes i, hvis det er mindre end 5 skove. Under alle omstændigheder viser analyserne, at udmøntning af Naturpakken kan blive et godt bidrag til at standse tilbagegangen i biodiversitet (jf. Aichi mål 12 under Biodiversitets Konventionen), idet ikke mindst den lange række af truede arter, som trives i urørt skov, får plads til at øge deres bestande.

Det økonomiske tab for de analyserede scenarier udgjorde afhængigt af forudsætninger 26-69 % af statsskovenes årlige netto indkomst fra skovbrug, og 38-46 % for de mest omkostningseffektive scenarier. Tabet kan reduceres og målopfyldelsen øges ved opdeling af relevante skove, så biodiversitetsmæssigt mindre vigtige dele af skovene drives uden øget beskyttelse, mens 2020-måls-arternes levesteder beskyttes svarende til arternes økologiske behov.

9.2 Lysåbne biotoper og deres arter

For at øge sandsynligheden for at nå de politisk vedtagne 2020-mål for de ikke skovlevende arter anbefales indsats gennemført hurtigst muligt for 370 identificerede kombinationer af sted og art, som kan gavnes af mere målrettet beskyttelse. Derudover bør indsats for andre forekomster af 33 navngivne truede og højt prioriterede arter generelt prioriteres højt på Naturstyrelsens lysåbne arealer. Mange af disse andre forekomster findes i habitatområder, fredede områder eller andre typer eksisterende beskyttelse, hvor indsats bedre kan målrettes de truede arters økologiske behov ved hjælp af de kvalitetssikrede data tilvejebragt i nærværende projekt.

Styrelsens naturforvaltning har mange af stederne allerede været gennemført løbende i en årrække, hvilket kan være en væsentlig årsag til, at de truede arter overhovedet har overlevet. Fortsættelse og yderligere målretning af indsatsen til at tage hensyn til de omhandlede truede arter anbefales, herunder også til de 277 dansk truede ikke-skovarter i prioritetsklasse 3, som er kendt fra styrelsens arealer. Det store antal arter kan gøre det vanskeligt at overskue på landsplan, men for den enkelte naturforvaltningsenhed og skov er antallet af arter typisk lavt, så indsats bør kunne tilrettelægges målrettet.

10. Referencer

Alexander, K.N.A. (2002) The invertebrates of living and decaying timber in Britain and Ireland - a provisional annotated checklist. English Nature Research Report No. 467, Peterborough, UK, 142 pp.

Andersson, L., & Appelqvist, T. (1990) The influence of Pleistocene megafauna on nemoral and boreonemoral ecosystems: an hypothesis with implications for nature conservation. Svensk Botanisk Tidskrift, 84(6), 355-368.

Ardron, J.A., Possingham, H.P., & Klein, C.J. (eds). (2010) Marxan Good Practices Handbook, Version 2. Pacific Marine Analysis and Research Association, Victoria, BC, Canada. 165 pages. www.pacmara.org.

Assmann, T. & Falke, B. (1997) Bedeutung von Hudelandschaften aus tierökologischer und naturschutzfachlicher Sicht. Schr.-R. f. Landschaftspfl. u. Natursch. 54:129-144, Bundesamt für Naturschutz,

Baagøe, H.J. & Jensen, T.S. (2007) Dansk Pattedyr Atlas. Gyldendal. 392 pp.

Bernes, C., Jonsson, B. G., Junninen, K., Lõhmus, A., Macdonald, E., Müller, J., & Sandström, J. (2015) What is the impact of active management on biodiversity in boreal and temperate forests set aside for conservation or restoration? A systematic map. Environmental Evidence, 4(1), 25.

Beyer, H. L., Dujardin, Y., Watts, M. E., & Possingham, H. P. (2016) Solving conservation planning problems with integer linear programming. Ecological Modelling, 328, 14-22.

Bladt, J., Brunbjerg, A.K., Moeslund, J.E., Petersen A.H. & Ejrnæs R. (2016) Appendix 6: Opdatering af biodiversitetskortet for Danmark 2015. DCE notat. 10 pp. http://dce.au.dk/fileadmin/dce.au.dk/Udgivelser/Notater_2016/Opdatering_biodiversitetskort_2015.pdf

Boch, S., Prati, D., Hessenmöller, D., Schulze, E. D., & Fischer, M. (2013) Richness of lichen species, especially of threatened ones, is promoted by management methods furthering stand continuity. PloS one, 8(1), e55461.

Bokdam, J., & Gleichman, M. (2000) Effects of grazing by free-ranging cattle on vegetation dynamics in a continental north-west European heathland. Journ. of Applied Ecology, 37:415-431.

Brunet, J., Fritz, Ö., & Richnau, G. (2010) Biodiversity in European beech forests – a review with recommendations for sustainable forest management. Ecological Bulletins, 53(7).

Buchwald, E. (2005) A hierarchical terminology for more or less natural forests in relation to sustainable management and biodiversity conservation. Proceedings: Third expert meeting on harmonizing forest-related definitions for use by various stakeholders. Food and Agriculture Organization of the United Nations, Rome, 17-19 January 2005.

Buchwald, E. (2012) Flora og vegetation på Tofte-ejendommen. s.154 - 209 i: Hald-Mortensen, P. (red.) Tofte Skov og Mose – Status 2012. Aage V Jensens Fonde. 387 pp.

Buchwald, E. & Heilmann-Clausen, J. (2016) Identifikation af arter og naturtyper i 2020 biodiversitetsmålene. Med særligt henblik på Naturstyrelsens arealer. Center for Makroøkologi, Evolution og Klima, Københavns Universitet. 30 pp., http://macroecology.ku.dk/pdf-files/Identifikation_af_arter_og_naturtyper_i_2020_biodiversitetsm_lene.pdf

Buchwald, E. & Heilmann-Clausen, J. (in prep.) How well do indicator driven conservation sites of the European Union cover other threatened species relevant for 2020 biodiversity targets? In preparation for Biological Conservation.

Buchwald, E. & Vikstrøm, T. (1991) 10 års pleje af en tilgroet eng ved Gentofte Sø. URT 15:3, 71 – 80.

Buchwald, E., Wind, P., Bruun, HH., Møller, PF., Ejrnæs, R. & Svart, HE. (2013) Hvilke planter er hjemmehørende i Danmark? Flora og Fauna 118:73-96.

Bunzel-Drüke, M., Böhm, C., Finck, P., Kämmer, G., Luick, R., Reisinger, E., Riecken, U., Riedel, J., Scharf, M. & Zimball, O. (2008) „Wilde Weiden". Praxisleitfaden für Ganzjahresbeweidung in Naturschutz und Landschaftsentwicklung. – Arbeitsgemeinschaft Biologischer Umweltschutz im Kreis Soest e.V., Bad Sassendorf-Lohne. 215 pp.

Buttenschøn, R.M. (2007) Græsning og høslæt i naturplejen. Skov- og Naturstyrelsen & Center for skov, landskab og planlægning, KU. 250 pp.

Cabeza, M., & Moilanen, A. (2001) Design of reserve networks and the persistence of biodiversity. Trends in ecology & evolution, 16(5), 242-248.

CBD (2010) COP 10 Decision X/2. Strategic Plan for Biodiversity 2011-2020. https://www.cbd.int/decision/cop/?id=12268

Damgaard, C.F., Strandberg, B., Nielsen, K.E., Bak, J.L. & Skov, F. (2007) Forvaltningsmetoder i N-belastede habitatnaturtyper. Danmarks Miljøundersøgelser, Aarhus Universitet. 45 s. – Faglig rapport fra DMU nr. 637 http://www.dmu.dk/Pub/FR637.pdf

DANBIF (2016) Oversigt over Danmarks dyr, planter, svampe m.v., DanBIF - Danish Biodiversity Information Facility, University of Copenhagen, www.allearter.dk (besøgt 1.februar 2016)

Dinesen, L., Romdal, T., Grell, M.B. & Buchwald, E. (2016) Udviklingen i antallet af ynglefugle i Danmark 1800-2012 II. Dansk Ornitologisk Forenings Tidsskrift 110: 201-206.

Dirzo, R., Young, H. S., Galetti, M., Ceballos, G., Isaac, N. J., & Collen, B. (2014) Defaunation in the Anthropocene. Science, 345(6195), 401-406.

Dubgaard, A., Jespersen, H.M.L., Laugesen, F.M., Hasler, B., Christensen, L.P., Martinsen, L., Källstrøm, M. & Levin, G. (2012) Økonomiske analyser af naturplejemetoder i beskyttede områder, Rapport nr. 211, Fødevareøkonomisk Institut, København. 120 pp.

Dudley, N. (Red.) (2008) Guidelines for Applying Protected Area Management Categories. Gland, Switzerland: IUCN. 86 pp.

EEA (2013) The European Grassland Butterfly Indicator: 1990 – 2011. EEA Technical report no.11/2013. European Environment Agency. 35 pp.

EIONET (2013a) Reporting under Article 12 of the Birds Directive (period 2008-2012). Member State Deliveries. Denmark. http://bd.eionet.europa.eu/activities/Reporting/Article_12/ Reports_2013/Member_State_Deliveries

EIONET (2013b) Reporting under Article 17 of the Habitats Directive (period 2007-2012). Member States Deliveries. Denmark. http://bd.eionet.europa.eu/activities/Reporting/Article_17/ Reports_2013/Member_State_Deliveries

Ejrnæs, R., Wiberg-Larsen, P., Holm, T.E., Josefson, A., Strandberg, B., Nygaard, B., Andersen, L.W., Winding, A., Termansen, M., Hansen, M.D.D., Søndergaard, M., Hansen, A.S., Lundsteen, S., Baattrup-Pedersen, A., Kristensen, E., Krogh, P.H., Simonsen, V., Hasler, B. & Levin, G. (2011) Danmarks biodiversitet 2010 – status, udvikling og trusler. Danmarks Miljøundersøgelser, Aarhus Universitet. 152 sider – Faglig rapport fra DMU nr. 815.

Eskildsen, A. (2015) Long-term effects of global change on the distribution, species richness and life history of butterflies. PhD thesis. Aarhus University, Dept. Bioscience. 112 pp.

Eskildsen, A., Carvalheiro, L.G., Kissling, W.D., Biesmeijer, J.C., Schweiger, O. & Høye, T. (2015) Ecological specialization matters: long-term trends in butterfly species richness and assemblage composition depend on multiple functional traits. Diversity and distributions 21:7, 792-802.

EU Council (1979) Council Directive of 2 April 1979 on the conservation of wild birds (79/409/EEC). Official J. Eur. Communities, (L103).

EU Council (1992) Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Union, 206, 7-50.

Feilberg, J. (Red.) (2004) Proceedings fra konference 6. marts 2004: Nåleskovens velsignelser og forbandelser. Flora og fauna 110 (3):1-138, http://jydsknaturhistorisk.dk/Florafauna/FloraogFauna2004-3.pdf

Flensted, K. K., Bruun, H. H., Ejrnæs, R., Eskildsen, A., Thomsen, P. F., & Heilmann-Clausen, J. (2016) Red-listed species and forest continuity–A multi-taxon approach to conservation in temperate forests. Forest Ecology and Management, 378, 144-159.

Fløjgaard, C., Bladt, J. & Ejrnæs, R. (2017) Naturpleje og arealstørrelser med særligt fokus på Natura 2000 områderne. Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi, 58 s. - Videnskabelig rapport fra DCE - Nationalt Center for Miljø og Energi nr. 228. http://dce2.au.dk/pub/SR228.pdf

Fog, K. (1993) Oplæg til forvaltningsplan for Danmarks padder og krybdyr. Skov- og Naturstyrelsen. 174 pp.

Fordham, D.A., Akcakaya, H.R., Araujo, M.B., Keith, D.A. & Brook, B.W. (2013) Tools for integrating range change, extinction risk and climate change information into conservation management. Ecography 36: 001–009

Fowler, D., Lessard, J.P. & Sanders, N.J. (2014) Niche filtering rather than partitioning shapes the structure of forest and communities. Journal of Animal Ecology 83: 943-952

Fredshavn, J., Søgaard, B., Nygaard, B., Johansson, L.S., Wiberg-Larsen, P., Dahl, K., Sveegaard, S., Galatius, A. & Teilmann, J. (2014) Bevaringsstatus for naturtyper og arter. Habitatdirektivets Artikel 17 rapportering. Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi. Videnskabelig rapport fra DCE – Nationalt Center for Miljø og Energi nr. 98 http://dce2.au.dk/pub/SR98.pdf, 54 pp.

Geldmann, J., Barnes, M., Coad, L., Craigie, I.D., Hockings, M. and Burgess, N.D. (2013) Effectiveness of terrestrial protected areas in reducing habitat loss and population declines. Biological Conservation 161: 230-238

Geldmann, J., Heilmann-Clausen, J., Holm, T.E., Levinsky, I., Markussen, B., Olsen, K., Rahbek, C. & Tøttrup, A.P. (2016) What determines spatial bias in citizen science? Exploring four recording schemes with different proficiency requirements. Diversity and Distributions 22:1139–1149. DOI: 10.1111/ddi.12477.

Geldmann, J., Joppa, L. N., & Burgess, N. D. (2014) Mapping change in human pressure globally on land and within protected areas. Conservation biology, 28(6), 1604-1616.

Götmark, F. (2013) Habitat management alternatives for conservation forests in the temperate zone: Review, synthesis, and implications. Forest Ecology and Management, 306, 292-307.

Hansen, S. F. & Vikstrøm, T. (2005) Høengene og fuglene. URT 29:3, 57 – 59.

Hartvig, P. (2015) Atlas Flora Danica. Gyldendal, Kbh. 3 bind. 1230 pp.

Heilmann-Clausen, J. & Aude, E. (2006) Forvaltning af dødt ved i naturnære bøgebevoksninger - til gavn for biodiversiteten? HabitatVision rapport 06-01-2006. Udarbejdet med støtte fra Skov- og Naturstyrelsens Praksisnære Forsøg. ISBN 87-991366-0-0. 36 pp.

Heilmann-Clausen, J. & Christensen, M. (2003) Fungal diversity on decaying beech logs - implications for sustainable forestry. Biodiversity and Conservation 12:5, s. 953-973.

Heilmann-Clausen, J. & Christensen, M. (2004) Does size matter? On the importance of various dead wood fractions for fungal diversity in Danish beech forests. Forest Ecology and Management 201:1 s. 105-119.

Heilmann-Clausen J., Aude E., van Dort K., Christensen M., Piltaver A., Veerkamp M., Walleyn R., Siller I., Standovár T. & Odor P. (2014) Communities of wood-inhabiting bryophytes and fungi on dead beech logs in Europe: reflecting substrate quality or shaped by climate and forest conditions? J. Biogeogr. 41:2269–2282.

Hicks, W.K., Whitfield, C.P., Bealey, W.J. & Sutton, M.A. (2011) Nitrogen Deposition and Natura 2000. Science and Practice in Determining Environmental Impacts. 293 pp. COST729/Nine/ESF/CCW/JNCC/SEI Workshop Proceedings. http://cost729.ceh.ac.uk/n2kworkshop

Huntley, B., Green, R. E., Collingham,Y. C., & Willis, S. G. (2007) A Climatic Atlas of European Breeding Birds. Durham University, RSPB and Lynx Edicions, Barcelona. 521 pp.

IUCN (2015) The IUCN Red List of Threatened Species. Denmark search May 2015, permalink: http://www.iucnredlist.org/search/link/554c4d07-c8f7a9d9 .

Jackson, S.T., Hobbs, R.J. (2009) Ecological restoration in the light of ecological history. Science 325, 567–569.

Johannsen, V. K., Dippel, T. M. , Møller, P. F. , Heilmann-Clausen, J., Ejrnæs, R., Larsen, J. B., Raulund-Rasmussen, K., Rojas, S. K., Jørgensen, B. B., Riis-Nielsen, T., Bruun, H. H. K., Thomsen, P. F., Eskildsen, A., Fredshavn, J., Kjær, E. D., Nord-Larsen, T., Caspersen, O. H., Hansen, G. K. (2013) Evaluering af indsatsen for biodiversiteten i de danske skove 1992-2012. KU/IGN, 90 pp.

Johannsen, V.K., Rojas,S.K., Brunbjerg, A.K., Schumacher, J., Bladt, J., Nyed, P.K., Moeslund, J.E., Nord-Larsen, T. og Ejrnæs, R. (2015) Udvikling af et High Nature Value - HNV-skovkort for Danmark. IGN Rapport November 2015, Institut for Geovidenskab og Naturforvaltning, Københavns Universitet.

Johannsen, V.K. & Schmidt, I.K. (2017) Udpegning af skov til biodiversitetsformål på statens arealer – strukturel analyse. IGN Rapport, december 2017, Institut for Geovidenskab og Naturforvaltning, Frederiksberg. 34 s. ill.

Joppa, L. N., O'Connor, B., Visconti, P., Smith, C., Geldmann, J., Hoffmann, M., ... & Ahmed, S. E. (2016) Filling in biodiversity threat gaps. Science, 352(6284), 416-418.

Jørgensen, H. (2005) Høenge i Danmark – en oversigt. URT 29:3, 3 – 7.

Jørgensen, H., & Karlog, T. (2005) Maskinel drift af høenge. URT 29:3, 44 – 48.

Justus, J., Fuller, T., & Sarkar, S. (2008) Influence of Representation Targets on the Total Area of Conservation-Area Networks. Conservation Biology, 22(3), 673-682.

Kahle, H. P. (Ed.) (2008) Causes and consequences of forest growth trends in Europe: Results of the recognition project (Vol. 21). Brill.

Knight, A. T., Cowling, R. M., Rouget, M., Balmford, A., Lombard, A. T., & Campbell, B. M. (2008) Knowing but not doing: selecting priority conservation areas and the research–implementation gap. Conservation biology, 22(3), 610-617.

Köhler, F. (2000) Saproxylic beetles in nature forests of the northern Rhineland. Comparative studies on the saproxylic beetles of Germany and contributions to German nature forest research (in german). - Schrr. LÖBF/LAfAO NRW (Recklinghausen) 18, 1-351. Database downloaded 17/3 2015 from http://www.koehleroptera.de/publikationen/buecher/totholz2000.html .

Kukkala, A. S., & Moilanen, A. (2013) Core concepts of spatial prioritisation in systematic conservation planning. Biological Reviews, 88(2), 443-464.

Kuuluvainen, T. (2009) Forest management and biodiversity conservation based on natural ecosystem dynamics in Northern Europe: the complexity challenge. Ambio 38, 309–315.

Landbrugs- og Fiskeristyrelsen (2017) Pleje af græs- og naturarealer (tilsagnstype 66 og 67) - 5-årige tilsagn. http://lfst.dk/tilskud-selvbetjening/tilskudsguide/pleje-af-graes-og-naturarealer-tilsagnstype-66-og-67-5-aarige-tilsagn/

Lindenmayer, D. B., & Franklin, J. F. (2002) Conserving forest biodiversity: a comprehensive multiscaled approach. Island Press.

Lindhe, A., Lindelöw, Å., & Åsenblad, N. (2005) Saproxylic beetles in standing dead wood density in relation to substrate sun-exposure and diameter. Biodiversity and Conservation, 14(12), 3033-3053.

Lõhmus, A. (2015) Collective analyses on “red-listed species” may have limited value for conservation ecology. Biodiversity and Conservation, 24(12), 3151-3153.

Lundström, J., Öhman, K., Rönnqvist, M., & Gustafsson, L. (2016) Considering future potential regarding structural diversity in selection of forest reserves. PloS one, 11(2), e0148960.

Mace GM, Collar NJ, Gaston KJ, et al. (2008) Quantification of extinction risk: IUCN's system for classifying threatened species. Conserv Biol 22: 1424–42.

Margules, C. R., & Pressey, R. L. (2000) Systematic conservation planning. Nature, 405(6783), 243.

Maroo, S. & Yalden, D.W. (2000) The Mesolithic mammal fauna of Great Britain. Mammal Review, 30, 243-248.

Mascia, M.B., Pailler, S., Thieme, M.L., Rowe, A., Bottrill, M.C., Danielsen, F., Geldmann, J., Naidoo., R., Pullin, A.S. & Burgess, N.D. (2014) Commonalities and Complementarities among Approaches to Conservation Monitoring and Evaluation. Biological Conservation 169: 258-267

Miljø- og Fødevareministeriet (2016) Aftale om Naturpakke, http://mfvm.dk/fileadmin/user_upload/Natturpakke-2016.pdf

Miljøstyrelsen (2017) Afbrænding. http://svana.dk/natur/national-naturbeskyttelse/beskyttede-naturtyper-3/naturplejeportalen/heder/hedepleje/afbraending/

Moilanen, A., Wilson, K. A., & Possingham, H. (2009) Spatial conservation prioritization: quantitative methods and computational tools (pp. 1-304). Oxford University Press.

Newbold, T., Hudson, L. N., Hill, S. L., Contu, S., Lysenko, I., Senior, R. A., ... & Day, J. (2015) Global effects of land use on local terrestrial biodiversity. Nature, 520(7545), 45-50.

Nielsen, A.B. (2009) Urskovslandskabets åbenhed og sammensætning og græsningens betydning i Atlantisk tid belyst ved palæobotaniske metoder. GEUS rapport 2009/23, 79 pp.

Nielsen, A. B. & Buchwald, E. (2010) Urskovslandskabets åbenhed og græsningens betydning. Skoven 2, 2010, 88-93.

Nieto, A. & Alexander, K.N.A. (2010) European red list of saproxylic beetles. Luxembourg. Publications Office of the European Union. 45 pp.

Nordén, B., Dahlberg, A., Brandrud, T.E., Fritz, Ö., Ejrnæs, R., Ovaskainen, O. (2014) Effects of Ecological Continuity on Species Richness and Composition in Forests and Woodlands: A Review. Ecoscience, 21(1):34-45.

Nord-Larsen, T., Johannsen, V. K., Riis-Nielsen, T., Thomsen, I. M., Suadicani, K., Vesterdal, L., ... Jørgensen, B. B. (2016) Skove og plantager 2015: Forest statistics 2015. Institut for Geovidenskab og Naturforvaltning, Københavns Universitet. 129 pp.

Odgaard, B.V. (1994) The Holocene vegetation history of northern West Jutland, Denmark. Opera Botanica 123.

Owen-Smith, R. N. (1992) Megaherbivores: the influence of very large body size on ecology. Cambridge university press.

Peterken G. 1996. Natural Woodland: Ecology and Conservation in Northern Temperate Regions. Cambridge (MA): Cambridge University. 522 pp.

Petersen, A.H, Strange, N., Anthon, S., Bjørner, T.B. & Rahbek, C. (2012) Bevarelse af biodiversiteten i Danmark. En analyse af indsats og omkostninger. Arbejdspapir 2012:2. De Økonomiske Råd. 107 sider.

Petersen, A.H., Strange, N., Anthon, S., Bjørner, T.B. & C. Rahbek (2016a) Conserving what, where and why? Cost-efficient measures to conserve biodiversity in Denmark. Journ. f. Nature Conservation 29:33-44.

Petersen, A. H., Lundhede, T., Bruun, H. H., Heilmann-Clausen, J., Thorsen, B. J., Strange, N., & Rahbek, C. (2016b) Bevarelse af biodiversiteten i de danske skove: en analyse af den nødvendige indsats, og hvad den betyder for skovens andre samfundsgoder. Center for Macroecology, evolution and Climate. University of Cåbnehagen. 113 pp.

Petersen, A.H., J. Bladt, H.H. Bruun, R. Ejrnæs, J. Heilmann-Clausen og C. Rahbek (2017) Biologiske anbefalinger om udpegning af skov til biodiversitetsformål på statens arealer. Forskningsbaseret rådgivning fra Københavns og Aarhus Universiteter i forbindelse med regeringens Naturpakke. Center for Makroøkologi, Evolution og Klima, Københavns Universitet. 40 s.

Pimm, S. L., Jenkins, C. N., Abell, R., Brooks, T. M., Gittleman, J. L., Joppa, L. N., ... & Sexton, J. O. (2014) The biodiversity of species and their rates of extinction, distribution, and protection. Science, 344(6187), 1246752.

Possingham, H., Wilson, K. A., Andelman, S. J., & Vynne, C. H. (2006) Protected areas: goals, limitations, and design. In: Groom, M. J., Meffe, G. K., & Carroll, C. R., Principles of conservation biology. Sunderland: Sinauer Associates., third ed. pp. 509-533.

Rigsrevisionen (2016) Beretning om Miljø- og Fødevareministeriets forvaltning af biodiversitet i statsskovene. 46 pp. http://www.rigsrevisionen.dk/media/2104276/sr1815.pdf

Risser, P. G. (1995) The status of the science examining eco-tones. Bioscience 45:318–325.

Sandom, C. J., Ejrnæs, R., Hansen, M. D. D. & Svenning, J-C. (2014) High herbivore density associated with vegetation diversity in interglacial ecosystems. In : National Academy of Sciences. Proceedings. 111, 11, p. 4162–4167.

Schröter, M., Rusch, G. M., Barton, D. N., Blumentrath, S., & Nordén, B. (2014) Ecosystem services and opportunity costs shift spatial priorities for conserving forest biodiversity. PloS one, 9(11), e112557.

Segan, D. B., Game, E. T., Watts, M. E., Stewart, R. R., & Possingham, H. P. (2011) An interoperable decision support tool for conservation planning. Environmental Modelling & Software, 26(12), 1434-1441.

Settele J., Kudrna O., Harpke A., Kühn I., van Swaay C., Verovnik R., Warren M., Wiemers M., Hanspach J., Hickler T., Kühn E., van Halder I., Veling K., Vliegenthart A., Wynhoff I., Schweiger O. (2008) Climatic Risk Atlas of European Butterflies. BioRisk 1 (special issue), 1-710. ISBN 978-954-642-454-9 (PB), 978-954-642-455-6 (HB). Pensoft, Sofia-Moscow.

Skipper, L. (2017) Allearter.dk - Status 2016. Oversigt over dansk biodiversitet. DanBIF - Danish Biodiversity Information Facility. www.allearter.dk

Skov, F., Svenning, J.-C. & Normand, S. (2006) Sandsynlige konsekvenser af klimaændringer på artsudbredelser og biodiversitet i Danmark - Potentielle konsekvenser af klimaændringer for artsudbredelser og biodiversitet i Danmark med karplanter som eksempel. − Miljøprojekt 1120. Miljøstyrelsen.

Skov- og Naturstyrelsen (1994) Strategi for de danske naturskove og andre bevaringsværdige skovtyper. Miljøministeriet, Skov- og Naturstyrelsen. 48 pp.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Folke, C. (2015) Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223), 1259855.

Stenild, J., Rasmussen, S. & Højland, J. (red.) (2016) Pleje af heder og indlandsklitter i Danmark – en metodehåndbog. LIFE projekt RAHID. Naturstyrelsen. 2016. 79 pp.

Stokland, J. N., & Meyke, E. (2008) The saproxylic database: an emerging overview of the biological diversity in dead wood. In Revue d'écologie, 2008, SUP10" 4ème Colloque sur la Conservation des Coléoptères Saproxyliques", Vivoin, Sarthe, FRA, 2006-06-27. Société nationale de protection de la nature et d'acclimatation de France, Paris (FRA). Database in development download 18/3 2015 fra http://radon.uio.no/wdd/Default.aspx?ShortcutNewObject=true

Stokland, J.N., Siitonen, J., Jonsson, B.G. (2012) Biodiversity in dead wood. Ecology, Biodiversity and Conservation Series. Cambridge University Press.

Stoltze, M., 2005: Sommerfugle på skovengen. URT 29:3, 34 - 35.

Svenning, J-C., Normand, S., & Skov, F. (2008) Konsekvenser af den globale opvarmning for den danske flora og vegetation. Flora og Fauna, 113(4), 111-120.

Søgaard, B. & Asferg, T. (red.) (2007) Håndbog om arter på habitatdirektivets bilag IV – til brug i administration og planlægning. Danmarks Miljøundersøgelser, Aarhus Universitet. – Faglig rapport fra DMU nr. 635. 226 s. http://www.dmu.dk/Pub/FR635.pdf

Tear, T. H., Kareiva, P., Angermeier, P. L., Comer, P., Czech, B., Kautz, R., ... & Scott, J. M. (2005) How much is enough? The recurrent problem of setting measurable objectives in conservation. AIBS Bulletin, 55(10), 835-849.

Timmermann, A., Damgaard, C., Strandberg, M. T., & Svenning, J. C. (2015) Pervasive early 21st-century vegetation changes across Danish semi-natural ecosystems: more losers than winners and a shift towards competitive, tall-growing species. Journal of applied ecology, 52(1), 21-30.

Tybirk, K., & Strandberg, B. (1999) Oak forest development as a result of historical land-use patterns and present nitrogen deposition. Forest ecology and management, 114(1), 97-106.

Vandekerkhove, K., De Keersmaeker, L., Walleyn, R., Köhler, F., Crevecoeur, L., Govaere, L., ... & Verheyen, K. (2012) Reappearance of old growth elements in lowland woodlands in northern Belgium: do the associated species follow?. Silva Fennica, 45(5), 909-935.

Venter, O., Fuller, R. A., Segan, D. B., Carwardine, J., Brooks, T., Butchart, S. H., ... & Possingham, H. P. (2014) Targeting global protected area expansion for imperiled biodiversity. PLoS Biology, 12(6), e1001891.

Venter, O., Magrach, A., Outram, N., Klein, C. J., Marco, M. D., & Watson, J. E. (2017) Bias in protected-area location and its effects on long-term aspirations of biodiversity conventions. Conservation Biology.

Vera, F. W. M. (2000) Grazing ecology and forest history. CABI publishing. 506 pp.

Vikstrøm, T., Nyegaard, T., Fenger, M., Brandtberg, N. & Thomsen, H. (2015) Status og udviklingstendenser for Danmarks Internationalt Vigtige Fugleområder (IBA'er). DOF rapport 17. 83 pp.

Virkkala, R., Heikkinen, R. K., Fronzek, S., & Leikola, N. (2013) Climate change, northern birds of conservation concern and matching the hotspots of habitat suitability with the reserve network. PLoS One, 8(5), e63376.

Watson, J. E., Darling, E. S., Venter, O., Maron, M., Walston, J., Possingham, H. P., ... & Brooks, T. M. (2016) Bolder science needed now for protected areas. Conservation Biology, 30(2), 243-248.

Watts, M. E., I. R. Ball, R. S. Stewart, C. J. Klein, K. Wilson, C. Steinback, R. Lourival, L. Kircher & H. P. Possingham (2009) Marxan with Zones – software for optimal conservation-based land- and sea-use zoning. Environmental Modelling & Software 24:1513-1521.

Watts, M. E., Steinback, C. & C. Klein (2008a) User Guide: Applying Marxan with Zones. North central coast of California marine study. University Of Queensland.

Watts, M. E., C. K. Klein, R. Stewart, I. R. Ball & H. P. Possingham (2008b) Marxan with Zones (V1.0.1): Conservation Zoning using Spatially Explicit Annealing, a Manual. University Of Queensland.

Watts, M., Stewart, R., Segan, D. & Kircher, L. (2011) Using the Zonae Cogito Decision Support System. Manual prepared by Applied Environmental Decision Analysis Centre. Ecology Centre, Univ. Queensland.

Wilson, K. A., Meijaard, E., Drummond, S., Grantham, H. S., Boitani, L., Catullo, G., ... & Watts, M. (2010) Conserving biodiversity in production landscapes. Ecological Applications, 20(6), 1721-1732.

Wind, P. & Ejrnæs, R. (2014) Danmarks truede arter. Den danske rødliste. Miljøbiblioteket 1, Aarhus Universitetsforlag. 181 pp.

Wind, P. & Pihl. S. (red.) (2010) Den danske rødliste. - Danmarks Miljøundersøgelser, Aarhus Universitet, [2004]-. http://redlist.dmu.dk (opdateret april 2010). Online database.

Bilag A. Undersøgelsens datakilder. Side 1 af 2 **Bilag A**

Data leverandør	Data total	Brugt	Dato hentet	Reference
DOFbasen, Atlas III & observationer (Birdlife Danmark)	17.961.625	110.029	17/12 2015	http://dofbasen.dk/
Fugle & Natur, naturbasen (licens B05/2014, Fugle & Natur)	1.958.677	57.401	2/12 2015	http://www.fugleognatur.dk/
Bugbase (Lepidopterologisk Forening)	859.969	23.689	21/12 2015	http://www.bugbase.dk/
Biodiversitets kortet, HNV-skov opdatering (Naturstyrelsen)	54.997	22.656	2/5 2016	Johannsen, V. K., 2015 & digital data 2/5 2016
Biodiversitets kortet 2014 (Naturstyrelsen)	23.185	20.919	9/12 2015	Ejrnæs et al. 2014 & digital opdatering hentet 9/12 2015
Danmarks Svampeatlas (Foreningen til Svampekundskabens Fremme)	559.159	20.358	17/11 2015	http://www.svampeatlas.dk/
Atlasprojektet Danmarks Dagsommerfugle (Zoologisk Museum)	199.307	5.288	15/1 2014	Stoltze, M., 1994
Artsdata fra § 25-skove sammenstillet af Cowi for Skov- og Naturstyrelsen	49.894	2.399	1/12 2015	Skov- og Naturstyrelsen 2007
Naturstyrelsens "Pas-paa-kort" med artsfund	8.526	1.865	3/11 2015	Naturstyrelsen 2015
Atlas Flora Danica data 1992-2013, rødliste & skov udtræk (Dansk Botanisk Forening)	123.334	1.459	22/4 2014	Hartvig, P., 2015
Entomologisk forening for Fyns database "Fynske insekter"	167.905	971	20/1 2016	http://www.fynskeinsekter.dk /
Danmarks Edderkopper (online database)	31.731	158	3/11 2015	http://www.danmarks-edderkopper.dk/
Epiphytic lichens and bryophytes in the forests of Lille Vildmose in 2013	210	81	19/4 2016	Fritz, Ô., 2014
Taginsekt studie 1992-2009 (Zoologisk Museum)	44.088	57	14/1 2016	Thomsen et al., 2015
Digitale databaser for invertebrater (Statens Naturhistoriske Museum)	69.436	35	1/12 2015	Stein, M., 2015
Biodiversitet, kvistflora og kvælstofbelastning, Kås Skov 2002	85	29	19/4 2016	Larsen, R.S., 2002
Epifytiske laver og mosser på eg i Tofte Skov 2012-2013	104	28	19/4 2016	Mouridsen, M.T., 2014
Status bøger om Tofte & Høstemark skovene	3.331	11	19/4 2016	Hald-Mortensen, P., 2012 & 2002
Dansk Topografisk Botanisk Undersøgelse online, "TBU"	3.299	5	21/12 2015	http://www.daim.snm.ku.dk/ TBU-en
Levermosser i Herbarium C (Statens Naturhistoriske Museum)	9.306	0	3/11 2015	http://www.daim.snm.ku.dk/ hepatics
Total	22.128.168	267.438	Total	

Bilag A. Undersøgelsens datakilder. Side 2 af 2 **Bilag A**

Referencer til bilag A:

Ejrnæs et al. (2014) *Biodiversitetskort for Danmark*. Rapp 112/2014, DCE.

Fritz, Ô. (2014) *Epiphytic lichens and bryophytes in the forests of Lille Vildmose in 2013*. Naturcentrum report 2014-03-04, 34 pp.

GBIF (2016) GBIF.org (5th September 2016) *GBIF Occurrence Download* http://doi.org/10.15468/dl.obr3f0. Tjekket men ej brugt, da det var dubletter.

Hald-Mortensen, P. (2002) *Høstemark - status 2001*. AVJF, 302 pp.

Hald-Mortensen, P. (2012) *Tofte Skov og Mose - status 2012*. AVJF, 387 pp.

Hartvig, P. (2015) *Atlas Flora Danica*. 3 volumes. Gyldendal, København.

Johannsen, V. K. (2015) *Udvikling af et High Nature Value - HNV-skovkort for Danmark*. IGN rapport, nov 2015.

Larsen, R.S. (2002) *Biodiversitet, kvistflora og kvælstofbelastning. Kås Skov, 2002*. KU speciale rapport.

Mouridsen, M.T. (2014) *Epifytiske laver og mosser på eg i Tofte Skov. Status 2012-13*. Specialerapport, KU Biol. Inst. 2014.

Naturstyrelsen (2015) *Databasen "Pas-paa-kort" Naturreg*. Upubliseret.

Naturstyrelsen (2016) *Digitalt biodiversitetskort 2016*, opdaterede ArcGis filer 18. marts 2016. Upubliceret.

Skov- og Naturstyrelsen (2007) *Artsdata fra 2007 COWI projektet " Naturmæssigt særlig værdifulde skove § 25"*. Upubliceret.

Stein. M., in litt. (2015) *RE: Forespørgsel på invertebratdata til mit PhD*. Email 1/12 2015 fra SNHM.

Stoltze, M. (1994) *An Annotated Atlas of the Danish Butterflies*. Zoologisk Museum, 134 pp.

Thomsen, P. F., Jørgensen, P. S., Bruun, H. H., Pedersen, J., Riis-Nielsen, T., Jonko, K., Słowińska, I., Rahbek, C., Karsholt, O. (2015) *Resource specialists lead local insect community turnover tilknyttet with temperature – analysis of an 18-year full-seasonal record of moths and beetles*. Journal of Animal Ecology. doi: 10.1111/1365-2656.12452.

Data for de 626 skovarter

Bilag B

Artsgruppe	Arts navn	Truet hvor?	Rødliste	Tilbagegå	Priorite	Præference	Saproxyl?	Gruppe	Zone	Skove	Match	gap?
Pattedyr	Bechsteins flagermus	EU anx 2 art	DD	ja	A	Løvskov	Ej-saproxyl	Åben skov	34	2	2	
Pattedyr	Brandts flagermus	EU anx 4 art	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	6		
Pattedyr	Bredøret flagermus	EU anx 2 art	VU	nej	A	Løvskov	Ej-saproxyl	Åben skov	3	4	3	gap1
Pattedyr	Brunflagermus	EU anx 4 art	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	54		
Pattedyr	Damflagermus	EU anx 2 art	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	3		
Pattedyr	Dværgflagermus	EU anx 4 art	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	39		
Pattedyr	Frynseflagermus	EU anx 4 art	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	14		
Pattedyr	Hare	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	321	82	
Pattedyr	Hasselmus	EU anx 4 art	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	5	5	
Pattedyr	Langøret flagermus	EU anx 4 art	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	8		
Pattedyr	Nordflagermus	EU anx 4 art	NA	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Pattedyr	Pipistrelflagermus	EU anx 4 art	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	3		
Pattedyr	Skægflagermus	EU anx 4 art	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	3		
Pattedyr	Skovmår	EU anx 5 art	NT	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	60		
Pattedyr	Sydflagermus	EU anx 4 art	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	16		
Pattedyr	Troldflagermus	EU anx 4 art	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	19		
Pattedyr	Ulv	EU anx 2 art	-	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Pattedyr	Vandflagermus	EU anx 4 art	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	30		
Fugle	Gulirisk	DK	VU	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	19		
Fugle	Havørn	EU anx 1 fugl	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	33		
Fugle	Hedelærke	EU anx 1 fugl	NT	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	105		
Fugle	Hvepsevåge	EU anx 1 fugl	LC	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	94		
Fugle	Lærkefalk	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	22		
Fugle	Lille fluesnapper	EU anx 1 fugl	NA	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	35		
Fugle	Natravn	EU anx 1 fugl	LC	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	87		
Fugle	Nøddekrige	DK	RE	RE	A	Nål obligat	Ej-saproxyl	Nål obligat	2	11	5	
Fugle	Perleugle	EU anx 1 fugl	NA	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	20		
Fugle	Pirol	DK	CR	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	43	25	
Fugle	Rødrygget tornskade	EU anx 1 fugl	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	201		
Fugle	Sortspætte	EU anx 1 fugl	LC	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	113		
Fugle	Stor hornugle	EU anx 1 fugl	NT	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	22		
Fugle	Stor skallesluger	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	22		
Fugle	Svaleklire	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	40		
Fugle	Trane	EU anx 1 fugl	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	72		
Fugle	Vendehals	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	59	17	
Padder	Butsnudet frø	EU anx 5 art	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	187		
Padder	Løvfrø	EU anx 4 art	LC	nej	A	Løvskov	Ej-saproxyl	Åben skov	3	40	9	
Padder	Spidssnudet frø	EU anx 4 art	LC	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	179	42	
Padder	Springfrø	EU anx 4 art	LC	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	26		
Padder	Stor vandsalamander	EU anx 2 art	LC	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	142	43	
Biller	Allandrus undulatus	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Biller	Allecula morio	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	3	1	0	gap1
Biller	Ampedus hjorti	Globalt	VU	nej	A	Løvskov	Saproxyl	Åben saproxyl	3	5	3	gap2
Biller	Ampedus quercicola	DK	VU	nej	B	Løvskov	Saproxyl	Åben saproxyl	3	1		
Biller	Azurbille	DK	VU	ja	A	Nål obligat	Saproxyl	Nål saproxyl	24	6	5	
Biller	Blodrød maskebille	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	2		
Biller	Bøgeløber	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Biller	Egeværftbille	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	2	2	
Biller	Eghjort	DK	RE	RE	A	Løvskov	Saproxyl	Åben saproxyl	3	2	0	gap2
Biller	Elmeloppe	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	2	
Biller	Eremit	EU anx 2 art	EN	ja	A	Løvskov	Saproxyl	Åben saproxyl	3	1	1	
Biller	Falsk skjoldbille	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	3	3	
Biller	Fyrregråbuk	DK	EN	nej	B	Nål obligat	Saproxyl	Nål saproxyl	24	2		
Biller	Glat løber	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	5	5	
Biller	Grøn pragttorbist	DK	CR	ja	A	Løvskov	Saproxyl	Åben saproxyl	3	1	0	gap1
Biller	Hallomenus axillaris	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	1	
Biller	Hasselbuk	DK	VU	nej	B	Løvskov	Saproxyl	Åben saproxyl	3	3		
Biller	Hypulus quercinus	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	1	
Biller	Klintoldenborre	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Biller	Lasiorhynchites cavifrons	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Biller	Lille langben	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Biller	Magdalis armigera	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	3	3	
Biller	Matsort træsmælder	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	3	5	3	gap2
Biller	Melasis buprestoides	DK	EN	nej	B	Løvskov	Saproxyl	Åben saproxyl	3	3		
Biller	Mycetophagus fulvicollis	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Biller	Neomida haemorrhoidalis	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	1	
Biller	Peltis ferruginea	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Biller	Pissodes validirostris	DK	VU	nej	B	Nål obligat	Saproxyl	Nål saproxyl	2	2		
Biller	Pragtsmælder	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	3	1	0	gap1
Biller	Rød skivebuk	DK	VU	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	8		
Biller	Rødbrystet maskebille	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	2	2	
Biller	Seksbåndet blomsterbuk	DK	EN	ja	A	Nål obligat	Saproxyl	Nål saproxyl	24	5	5	
Biller	Smaragdina salicina	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	

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Bilag B

Artsgruppe	Arts navn	Truet hvor?	Rødliste	Tilbagegå	Priorite	Præference	Saproxyl?	Gruppe	Zone	Skove	Match	gap?
Biller	Sort blomsterbuk	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	12	4	gap1
Biller	Sort spidsbuk	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	3	2	2	
Biller	Stor cylinderbille	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	1	
Biller	Stor elmebarkbille	DK	EN	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	1	1	
Biller	Stor malakitbille	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	3	2	2	
Biller	Stor skovsmælder	DK	VU	nej	B	Nål obligat	Saproxyl	Nål saproxyl	24	5		
Biller	Tachyta nana	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	3	1	0	gap1
Biller	Tetrops starkii	DK	VU	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	1		
Biller	Tofarvet hedeløber	DK	VU	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	2	2	
Biller	Urskovshvepsebuk	DK	RE	RE	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	1	
Biller	Xylophilus corticalis	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	2	2	
Tovinger	Asiatisk løgsvirreflue	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Tovinger	Bjerg-svirreflue	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	13	5	
Tovinger	Broget urtesvirreflue	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	11	5	
Tovinger	Brun bjørnesvirreflue	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	24	10	
Tovinger	Brun træsmuldsvirreflue	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	9	5	
Tovinger	Dværg-svirreflue	DK	VU	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	1	1	
Tovinger	Fyrre-træsmuldsvirreflue	DK	VU	ja	A	Nål obligat	Saproxyl	Nål saproxyl	24	8	5	
Tovinger	Gul bjørnesvirreflue	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	6	5	
Tovinger	Gul humlesvirreflue	DK	VU	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	3		
Tovinger	Gul træhulflue	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	6	5	
Tovinger	Gulbenet urtesvirreflue	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	4		
Tovinger	Hvidbåndet rovflue	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	1	gap1
Tovinger	Jordhumle-svirreflue	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	3	3	
Tovinger	Lille træsvirreflue	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	3	2	gap1
Tovinger	Lysende svirreflue	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Tovinger	Mørk myresvirreflue	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	6	4	gap1
Tovinger	Nyre-træsaftsvirreflue	DK	EN	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	1	1	
Tovinger	Panzers træsaftsvirreflue	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	8		
Tovinger	Pragtsvirreflue	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	2	1	gap1
Tovinger	Skinnende træsvirreflue	DK	EN	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	2	2	
Tovinger	Smuk løgsvirreflue	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	1	gap1
Tovinger	Sort hårsvirreflue	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Tovinger	Sort træsmuldsvirreflue	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	4	2	gap2
Tovinger	Sort vedrovflue	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	4	1	gap3
Tovinger	Sortmundet glanssvirreflue	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Tovinger	Stikkelsbær-glanssvirreflue	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	4	2	gap2
Tovinger	Sump-urtesvirreflue	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	0	gap1
Tovinger	Temnostoma meridionale	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	4	4	
Tovinger	Tidlig ornamentsvirreflue	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	5	3	gap2
Tovinger	Tofarvet træsaftsvirreflue	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	2	2	
Tovinger	Uldhåret pelssvirreflue	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	5	4	gap1
Tovinger	Uld-svirreflue	DK	EN	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	6	6	
Tovinger	Verralls hvepsesvirreflue	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	2	
Tæger	Birkebarktæge	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	6	6	
Tæger	Karsetæge	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Tæger	Toplettet urtetæge	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	2	
Årevinger	Blank gæstemyre	Globalt	VU	nej	A	Nål obligat	Ej-saproxyl	Nål obligat	2	5	3	gap2
Årevinger	Enghumle	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	5	5	
Dagsommerf	Brun pletvinge	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	12	5	
Dagsommerf	Det hvide w	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	97	34	
Dagsommerf	Enghvidvinge	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	2	
Dagsommerf	Guldhale	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	54	24	
Dagsommerf	Kejserkåbe	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	132	46	
Dagsommerf	Kirsebærtakvinge	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	5	3	gap2
Dagsommerf	Perlemorrandøje	DK	RE	RE	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Dagsommerf	Rødlig perlemorsommerfugl	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	7	4	gap1
Dagsommerf	Skovhvidvinge	DK	RE	RE	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Dagsommerf	Skovperlemorsommerfugl	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	46	13	
Sommerfugle	Askegraa lavspinder	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	17		
Sommerfugle	Birkespinder	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Sommerfugle	Blegpandet lavspinder	DK	EN	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	4		
Sommerfugle	Bøgeskovspinder	DK	VU	ja	A	Løvskov	Ej-saproxyl	Urørt løvskov	34	4	4	
Sommerfugle	Brachionycha nubeculosa	DK	RE	RE	A	Løvskov	Ej-saproxyl	Åben skov	3	1	0	gap1
Sommerfugle	Brunrods-hætteugle	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	13	6	
Sommerfugle	Dværgspinder	DK	CR	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	4	3	gap1
Sommerfugle	Grå dromedarspinder	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Sommerfugle	Grå landmand	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	2	
Sommerfugle	Gran-nonne	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	3	0	gap3
Sommerfugle	Højmose-tiggerugle	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Sommerfugle	Hønsetarm-glansugle	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	3		
Sommerfugle	Hyrdeugle	DK	CR	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Sommerfugle	Natlyssværmer	EU anx 4 art	NA	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		

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Artsgruppe	Arts navn	Truet hvor?	Rødliste	Tilbageg	Priorite	Præference	Saproxyl?	Gruppe	Zone	Skove	Match	gap?
Sommerfugle	Pilplet-ugle	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	8	6	
Sommerfugle	Pragt grønsagsugle	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	3	3	
Sommerfugle	Ringspinder	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	26	12	
Sommerfugle	Rødbrun ordenugle	DK	RE	RE	A	Løvskov	Ej-saproxyl	Åben skov	3	4	3	gap1
Sommerfugle	Rustplettet ugle	DK	RE	RE	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	1	1	
Sommerfugle	Skinnende jordfarveugle	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	34	4	4	
Sommerfugle	Skovbjørn	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	6	5	
Sommerfugle	Stenkløver-køllesværmer	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	13	5	
Sommerfugle	Stribet målerugle	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	4	3	gap1
Sommerfugle	Tjørnespinder	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	13	7	
Sommerfugle	Trapez-glansugle	DK	RE	RE	A	Løvskov	Ej-saproxyl	Åben skov	3	1	0	gap1
Sommerfugle	Treforkugle	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	9	5	
Sommerfugle	Uldhale	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	8	5	
Guldsmede	Stor kærguldsmed	EU anx 2 art	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	22	6	
Græshopper	Stor enggræshoppe	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	4	1	gap3
Edderkopper	Araneus triguttatus	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Edderkopper	Dendryphantes rudis	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	1		
Edderkopper	Hygrolycosa rubrofasciata	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Edderkopper	Marmoreret hjulspinder	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	9	5	
Edderkopper	Midia midas	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	0	gap1
Edderkopper	Orange hjulspinder	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	1	gap1
Edderkopper	Stor pukkelhjulspinder	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	2	2	
Mosskorpion	Stellas mosskorpion	EU anx 2 art	-	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	2		
Snegle	Skæv vindelsnegl	EU anx 2 art	-	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	16	6	
Snegle	Sumpvindelsnegl	Globalt	VU	nej	A	Løvskov	Ej-saproxyl	Anden løvskov	34	19	11	
Snegle	Vinbjergsnegl	EU anx 5 art	-	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	101		
Sæksvampe	Brun kuldyne	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	7		
Sæksvampe	Brun marchandiomyces	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	4		
Sæksvampe	Elaphomyces anthracinus	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Sæksvampe	Furestokket foldhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	1		
Sæksvampe	Helvella albella	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	3		
Sæksvampe	Kæmpe-stenmorkel	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	3	1	gap2
Sæksvampe	Kulsort kuldyne	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	5		
Sæksvampe	Queléts foldhat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	8	6	
Basidiesvamp	Abrikos-huesvamp	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	5		
Basidiesvamp	Abrikos-koralsvamp	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	8	7	
Basidiesvamp	Ædelgran-mælkehat	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	7	2	gap3
Basidiesvamp	Afblegende kam-fluesvamp	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Basidiesvamp	Agerhøne-champignon	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	3		
Basidiesvamp	Amanita olivaceogrisea	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	4		
Basidiesvamp	Amaurodon cyaneus	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	34	1		
Basidiesvamp	Anis-læderhat	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Anis-skørhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Basidiesvamp	Antrodia malicola	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	5		
Basidiesvamp	Askegrå sneglehat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Basidiesvamp	Askehvid mørkhat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	3	3	
Basidiesvamp	Athelidium aurantiacum	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	1	
Basidiesvamp	Avnbøg-skørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Basidiesvamp	Bæger-tåresvamp	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Bæltet korkpigsvamp	DK	VU	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	24	17	
Basidiesvamp	Bæltet mælkehat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	1		
Basidiesvamp	Bævrekølle	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	9	8	
Basidiesvamp	Banan-slørhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Bestøvlet tragthat	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	5	5	
Basidiesvamp	Bitter korkpigsvamp	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	7	5	
Basidiesvamp	Blåfodet kødpigsvamp	DK	CR	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	4	3	gap1
Basidiesvamp	Blålig filthat	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	2		
Basidiesvamp	Blålig korkpigsvamp	DK	CR	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	9	7	
Basidiesvamp	Bleg koralsvamp	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	11	8	
Basidiesvamp	Bleg rørhat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	4	4	
Basidiesvamp	Bleg skærmhat	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	34	9	9	
Basidiesvamp	Blodplettet koralsvamp	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	15	10	
Basidiesvamp	Blodrød skørhat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	16		
Basidiesvamp	Bøge-rødblad	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	6		
Basidiesvamp	Børstehåret savbladhat	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	18		
Basidiesvamp	Børstehåret spejlporesvamp	DK	VU	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	1		
Basidiesvamp	Børstepigsvamp	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	28	25	
Basidiesvamp	Børsteporesvamp	DK	EN	ja	A	Nål obligat	Saproxyl	Nål saproxyl	24	10	8	
Basidiesvamp	Brændende mælkehat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	6	5	
Basidiesvamp	Brandgul fagerhat	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	2	1	gap1
Basidiesvamp	Bronze-parasolhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	4	2		
Basidiesvamp	Bronze-rørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	3		
Basidiesvamp	Brun skørhat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	3		

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Artsgruppe	Arts navn	Truet hvor?	Rødliste	Tilbagega	Priorite	Præference	Saproxyl?	Gruppe	Zone	Skove	Match	gap?
Basidiesvamp	Brungul fagerhat	DK	VU	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	4		
Basidiesvamp	Brungul rødblad	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	5	4	gap1
Basidiesvamp	Brungul vokshat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Basidiesvamp	Brunlig koralpig	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Brusk-bævretop	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	4	3	gap1
Basidiesvamp	Bulliards slørhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Chromocyphella muscicola	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	1		
Basidiesvamp	Cinnober-muslingesvamp	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	0	gap1
Basidiesvamp	Cinnober-slørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	20		
Basidiesvamp	Clavulinopsis microspora	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	6		
Basidiesvamp	Coprinopsis pannucioides	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	2		
Basidiesvamp	Corticium expallens	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Cortinarius acetosus	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	4		
Basidiesvamp	Cortinarius aureocalceolatus	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Cortinarius betulinus	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Cortinarius caesiostramineus	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Cortinarius cagei	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Cortinarius catharinae	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Cortinarius cisticola	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Cortinarius fulvocitrinus	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	2		
Basidiesvamp	Cortinarius imperialis	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Cortinarius insignibulbus	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Cortinarius langeorum	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Cortinarius luteoimmarginatus	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Cortinarius multiformium	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	3		
Basidiesvamp	Cortinarius quarciticus	DK	VU	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	2	3		
Basidiesvamp	Cortinarius saporatus	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Cortinarius selandicus	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Cortinarius serratissimus	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Cortinarius talus	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	8		
Basidiesvamp	Cortinarius tophaceus	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Basidiesvamp	Cortinarius urbicus	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Cortinarius violaceocinereus	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Cortinarius xantho-ochraceus	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	2		
Basidiesvamp	Cristinia gallica	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	3		
Basidiesvamp	Daddelbrun slørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Dendrothele commixta	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	34	8		
Basidiesvamp	Djævle-rørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Dråbehat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	4		
Basidiesvamp	Drue-koralsvamp	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	18	15	
Basidiesvamp	Duftende kæmpeskælhat	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	5	4	gap1
Basidiesvamp	Duft-ridderhat	DK	EN	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	5		
Basidiesvamp	Duft-slørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	2		
Basidiesvamp	Dunet fnugfod	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Dunet pælerodshat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Basidiesvamp	Dunstokket posesvamp	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	4		
Basidiesvamp	Ege-ildporesvamp	DK	EN	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	1		
Basidiesvamp	Ege-spejlporesvamp	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	9	6	
Basidiesvamp	Egetunge	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	34	2	2	
Basidiesvamp	Elegant parasolhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	4	5		
Basidiesvamp	Elfenbens-mælkehat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	4		
Basidiesvamp	Elfenbens-rørhat	DK	CR	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	1		
Basidiesvamp	Elmehat	DK	EN	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	1	1	
Basidiesvamp	Ensfarvet læderporesvamp	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	10	5	
Basidiesvamp	Entoloma lampropus	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	3	2	gap1
Basidiesvamp	Entoloma parkensis	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Entoloma plebejum	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	1		
Basidiesvamp	Farvebold	DK	VU	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	1		
Basidiesvamp	Filtet korkpigsvamp	DK	CR	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	4		
Basidiesvamp	Filtet pælerodshat	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	34	3		
Basidiesvamp	Finskællet parasolhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	7		
Basidiesvamp	Finskællet skælhat	DK	VU	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	10	7	
Basidiesvamp	Firefarvet slørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	6		
Basidiesvamp	Firfliget stjernebold	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	2	2	
Basidiesvamp	Flammeporesvamp	DK	EN	nej	B	Nål obligat	Saproxyl	Nål saproxyl	24	20		
Basidiesvamp	Fløjls-mælkehat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	4		
Basidiesvamp	Flosset fluesvamp	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	4		
Basidiesvamp	Frugt-kalkskind	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	5		
Basidiesvamp	Frynset stilkbovist	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Basidiesvamp	Furestokket fladhat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	4		
Basidiesvamp	Fyrre-ildporesvamp	DK	VU	ja	A	Nål obligat	Saproxyl	Nål saproxyl	24	7	5	
Basidiesvamp	Fyrre-vatporesvamp	DK	EN	nej	B	Nål fakultativ	Saproxyl	Nål saproxyl	24	3		
Basidiesvamp	Giftig rødblad	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	3	3	

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Artsgruppe	Arts navn	Truet hvor?	Rødliste	Tilbagega	Priorite	Præference	Saproxyl?	Gruppe	Zone	Skove	Match	gap?
Basidiesvamp	Giftrød skørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	7		
Basidiesvamp	Glat ildporesvamp	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	2	1	gap1
Basidiesvamp	Gloeocystidiellum clavuligerur	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Grå kantarel	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	20	16	
Basidiesvamp	Grå troldhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Basidiesvamp	Gråbrun gråblad	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	3		
Basidiesvamp	Gråbrun parasolhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	6		
Basidiesvamp	Gracil slørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Grædende parasolhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	3		
Basidiesvamp	Grågrøn parasolhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	3		
Basidiesvamp	Grånende skørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Gråsort silkehat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	5		
Basidiesvamp	Gråviolet mælkehat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Basidiesvamp	Grenet fladhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	3		
Basidiesvamp	Grønfodet trævlhat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Basidiesvamp	Grøngul pastelporesvamp	DK	RE	RE	A	Løvskov	Saproxyl	Saproxyl skovart	4	5	5	
Basidiesvamp	Grøngul ridderhat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	5	5	
Basidiesvamp	Grønskællet parasolhat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Urørt løvskov	4	9	5	
Basidiesvamp	Grov sejporesvamp	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Grubestokket mælkehat	DK	EN	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	24	1		
Basidiesvamp	Grubet korkpigsvamp	DK	RE	RE	A	Nål obligat	Ej-saproxyl	Nål obligat	2	1	1	
Basidiesvamp	Guirlande-parasolhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	1		
Basidiesvamp	Gul ege-rørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	4		
Basidiesvamp	Gul trævlhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	4		
Basidiesvamp	Gul troldhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	4	2		
Basidiesvamp	Guldrørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	4		
Basidiesvamp	Gulgrå køllesvamp	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	7	5	
Basidiesvamp	Gulgrøn slørhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Gullig parasolhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	2		
Basidiesvamp	Gulnende skørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	6		
Basidiesvamp	Gylden grynskælhat	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	4	3	gap1
Basidiesvamp	Gylden koralsvamp	DK	CR	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Gyldenbrun lakporesvamp	DK	EN	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	3		
Basidiesvamp	Halsbånd-ridderhat	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	14	6	
Basidiesvamp	Hasselporesvamp	DK	RE	RE	A	Løvskov	Saproxyl	Saproxyl skovart	34	4	4	
Basidiesvamp	Højskællet parasolhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	1		
Basidiesvamp	Højstokket ridderhat	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	3	1	gap2
Basidiesvamp	Honning-skørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	9		
Basidiesvamp	Hovformet filthat	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	1	
Basidiesvamp	Hul-blækhat	DK	EN	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	1		
Basidiesvamp	Hvælvet gift-slørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	4		
Basidiesvamp	Hvid pigsvamp	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	3		
Basidiesvamp	Hvidlig skiveskorpe	DK	CR	ja	A	Løvskov	Saproxyl	Saproxyl skovart	34	2	2	
Basidiesvamp	Hygrophorus nemoreus	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Hyphoderma macedonicum	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	2		
Basidiesvamp	Hyphoderma medioburiense	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	5	5	
Basidiesvamp	Hypholoma ericaeum	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	0	gap1
Basidiesvamp	Inocybe margaritispora	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Inocybe quietiodor	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Inocybe sambucina	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	2	1	gap1
Basidiesvamp	Isabellafarvet køllesvamp	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Basidiesvamp	Jod-skørhat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	6		
Basidiesvamp	Kål-bruskhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	3		
Basidiesvamp	Kål-fladhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Basidiesvamp	Kandis-tåreblad	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	5		
Basidiesvamp	Kantet ridderhat	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	11	7	
Basidiesvamp	Kliddet parasolhat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Urørt løvskov	4	5	5	
Basidiesvamp	Klidhat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	23	13	
Basidiesvamp	Knippe-ridderhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	3		
Basidiesvamp	Kødfarvet grenkølle	DK	VU	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	5		
Basidiesvamp	Kokosbrun mælkehat	DK	VU	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	2	6		
Basidiesvamp	Kølle-guldgaffel	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	3		
Basidiesvamp	Køllekantarel	DK	CR	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Basidiesvamp	Kornet skørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	7		
Basidiesvamp	Krat-vokshat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	4		
Basidiesvamp	Kromgul vokshat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	13	7	
Basidiesvamp	Krumskællet trævlhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Kulkantarel	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	3	1	1	
Basidiesvamp	Kul-skørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	12		
Basidiesvamp	Labyrint-kødporesvamp	DK	CR	nej	B	Løvskov	Saproxyl	Saproxyl skovart	34	7		
Basidiesvamp	Lærke-mælkehat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	7		
Basidiesvamp	Lærke-sneglehat	DK	CR	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	1		
Basidiesvamp	Lakrids-ridderhat	DK	EN	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	7		

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Artsgruppe	Arts navn	Truet hvor?	Rødliste	Tilbagegå	Priorite	Præference	Saproxyl?	Gruppe	Zone	Skove	Match	gap?
Basidiesvamp	Lak-skørhat	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	4	3	gap1
Basidiesvamp	Lamel-rørhat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	11	9	
Basidiesvamp	Lav agerhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	3		
Basidiesvamp	Lilla skørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	8		
Basidiesvamp	Lillebitte skørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Basidiesvamp	Løvegul skærmhat	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	9	5	
Basidiesvamp	Løv-tjæreporesvamp	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	28		
Basidiesvamp	Magisk slørhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Maj-rødblad	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	4	2	gap2
Basidiesvamp	Mandel-skørhat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	3		
Basidiesvamp	Medusa-mørkhat	DK	CR	ja	A	Nål obligat	Saproxyl	Nål saproxyl	24	2	2	
Basidiesvamp	Mel-slørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Møllers parasolhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	3		
Basidiesvamp	Mønster-lædersvamp	DK	CR	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	2	1	gap1
Basidiesvamp	Mørk fagerhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	3		
Basidiesvamp	Mørk fnugfod	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Mørk læderpigsvamp	DK	VU	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	15	13	
Basidiesvamp	Mørk spidshat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	1		
Basidiesvamp	Musegrå posesvamp	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	34	4	4	
Basidiesvamp	Mycena clavata	DK	VU	nej	B	Nål obligat	Saproxyl	Nål saproxyl	24	11		
Basidiesvamp	Nubret parasolhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	4	2		
Basidiesvamp	Orange åresvamp	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	2		
Basidiesvamp	Orange korkpigsvamp	DK	CR	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	8	6	
Basidiesvamp	Orangebrun troldhat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	4	2	2	
Basidiesvamp	Orangefodet parasolhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Basidiesvamp	Orangegul ridderhat	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	6	3	gap2
Basidiesvamp	Orangegylden slørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	5		
Basidiesvamp	Orangerosa skørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	6		
Basidiesvamp	Ørnebregne-løghat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Park-sandporesvamp	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Basidiesvamp	Pelargonie-mælkehat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Basidiesvamp	Pelargonie-skørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	9		
Basidiesvamp	Perlehøne-champignon	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	6		
Basidiesvamp	Phlebia subserialis	DK	VU	nej	B	Nål fakultativ	Saproxyl	Nål saproxyl	24	1		
Basidiesvamp	Pigget fluesvamp	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Basidiesvamp	Pigget frynsehinde	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	3		
Basidiesvamp	Pigget grynskælhat	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	6		
Basidiesvamp	Pighud	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	2	2	
Basidiesvamp	Pindsvinepigsvamp	DK	CR	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	8	7	
Basidiesvamp	Pjaltet læderpigsvamp	DK	EN	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	7		
Basidiesvamp	Pjusket duftpigsvamp	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	8	5	
Basidiesvamp	Pluteus exiguus	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	3		
Basidiesvamp	Pluteus insidiosus	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	3		
Basidiesvamp	Porfyrgrå rødblad	DK	CR	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Basidiesvamp	Porotheleum fimbriatum	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	3		
Basidiesvamp	Prægtig mælkehat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	8	5	
Basidiesvamp	Prægtig slørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	2		
Basidiesvamp	Psathyrella spintrigeroides	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	3		
Basidiesvamp	Puklet skørhat	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	9	5	
Basidiesvamp	Punktstokket vokshat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	0	gap1
Basidiesvamp	Purpur-champignon	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	14		
Basidiesvamp	Purpurstokket slørhat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Basidiesvamp	Purpur-voksporesvamp	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	10		
Basidiesvamp	Ramaria flavescens	DK	CR	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Ramaria krieglsteineri	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	5		
Basidiesvamp	Ramaria suecica	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	6		
Basidiesvamp	Rødbrun spidshat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	1		
Basidiesvamp	Rod-gråblad	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	4	4	
Basidiesvamp	Rødlig bruskhat	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	3		
Basidiesvamp	Rødmende alfehat	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	34	5	5	
Basidiesvamp	Rødmende silkehat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	1		
Basidiesvamp	Røggrå mælkehat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	7		
Basidiesvamp	Rosa fedtporesvamp	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	9		
Basidiesvamp	Rosa pastelporesvamp	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	4	4	
Basidiesvamp	Rosa støvbold	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Basidiesvamp	Rosafodet skærmhat	DK	EN	nej	B	Nål obligat	Saproxyl	Nål saproxyl	24	1		
Basidiesvamp	Rosalilla rødblad	DK	EN	ja	A	Løvskov	Ej-saproxyl	Urørt løvskov	4	2	0	gap2
Basidiesvamp	Rosazonet trævlhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Rundsporet slørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	2		
Basidiesvamp	Rusporet keglehat	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Russula helodes	DK	EN	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	7		
Basidiesvamp	Russula pallidospora	DK	CR	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Russula persicina	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		

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Artsgruppe	Arts navn	Truet hvor?	Rødliste	Tilbagegå	Priorite	Præference	Saproxyl?	Gruppe	Zone	Skove	Match	gap?
Basidiesvamp	Rust-korkpigsvamp	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	10	5	
Basidiesvamp	Safrankødet slørhat	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	8	5	
Basidiesvamp	Safran-slørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	3		
Basidiesvamp	Sand-skørhat	DK	EN	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	1		
Basidiesvamp	Sarcodon lepidus	DK	CR	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	2		
Basidiesvamp	Sart rødblad	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	3		
Basidiesvamp	Satans rørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Basidiesvamp	Sej fedtporesvamp	DK	EN	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	6	5	
Basidiesvamp	Silke-parasolhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	1		
Basidiesvamp	Silke-ridderhat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	26	20	
Basidiesvamp	Simocybe sumptuosa	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	4		
Basidiesvamp	Sirene-slørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Skællet fåreporesvamp	DK	CR	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Basidiesvamp	Skællet filthat	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	9		
Basidiesvamp	Skællet kødpigsvamp	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	17	6	
Basidiesvamp	Skællet slørhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Skæv rødblad	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	1	
Basidiesvamp	Skarlagen-skærmhat	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	34	1	1	
Basidiesvamp	Skønfodet slørhat	DK	RE	RE	A	Nål obligat	Ej-saproxyl	Nål obligat	23	1	1	
Basidiesvamp	Skorpe-tåresvamp	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	2		
Basidiesvamp	Småskællet kødpigsvamp	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	22	12	
Basidiesvamp	Smuk koralsvamp	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	4	4	
Basidiesvamp	Snyltende posesvamp	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	10		
Basidiesvamp	Sodbrun sneglehat	DK	CR	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	1	1	
Basidiesvamp	Sødtduftende mørkhat	DK	EN	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	1		
Basidiesvamp	Sødtduftende parasolhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	4		
Basidiesvamp	Sølvskinnende rørhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Sort køllesvamp	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Basidiesvamp	Sortanløbende trævlhat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Sortfodet stilkporesvamp	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	5	4	gap1
Basidiesvamp	Sorthvid skørhat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Urørt løvskov	34	9	7	
Basidiesvamp	Sorthvid troldporesvamp	DK	CR	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	2		
Basidiesvamp	Sortrandet skærmhat	DK	VU	ja	A	Nål obligat	Saproxyl	Nål saproxyl	24	9	5	
Basidiesvamp	Spatel-filthat	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	3	3	
Basidiesvamp	Spiselig mælkehat	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	32	12	
Basidiesvamp	Steccherinum litschaueri	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	2		
Basidiesvamp	Steccherinum subcrinale	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	1	
Basidiesvamp	Stinkende fladhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	4		
Basidiesvamp	Stinkende slørhat	DK	VU	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	8		
Basidiesvamp	Stivhåret skærmhat	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	5		
Basidiesvamp	Stødrørhat	DK	CR	nej	B	Nål obligat	Saproxyl	Nål saproxyl	24	7		
Basidiesvamp	Stor blækhat	DK	VU	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	2		
Basidiesvamp	Stor filthat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Basidiesvamp	Stor grenkølle	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	1	1	
Basidiesvamp	Stor kanelporesvamp	DK	CR	ja	A	Løvskov	Saproxyl	Åben saproxyl	34	1	1	
Basidiesvamp	Stor spidshat	DK	EN	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	2		
Basidiesvamp	Strågul køllesvamp	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	6	4	gap1
Basidiesvamp	Stridhåret rødblad	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	4	1		
Basidiesvamp	Stypella dubia	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Stypella subgelatinosa	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	7		
Basidiesvamp	Sværtende gråblad	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	8	5	
Basidiesvamp	Sværtende kantarel	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	4		
Basidiesvamp	Tæge-rødblad	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	34	2	2	
Basidiesvamp	Tæge-vokshat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	10	6	
Basidiesvamp	Teglfarvet mælkehat	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	2	1	gap1
Basidiesvamp	Teglrød korkpigsvamp	DK	CR	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Thallus-navlehat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	34	1	1	
Basidiesvamp	Tobaksbrun agerhat	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Tofarvet foldporesvamp	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	5	2	gap3
Basidiesvamp	Tomentella italica	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Tomentella lateritia	DK	VU	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	3	1	gap2
Basidiesvamp	Tomentella pilosa	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	2		
Basidiesvamp	Tomentella umbrinospora	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	9		
Basidiesvamp	Topporesvamp	DK	CR	ja	A	Løvskov	Saproxyl	Saproxyl skovart	34	2	2	
Basidiesvamp	Tør ridderhat	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	10	6	
Basidiesvamp	Tragtformet læderpigsvamp	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	17	10	
Basidiesvamp	Trechispora silvae-ryae	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Trefarvet tragtridderhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Tricholoma basirubens	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Trompetkølle	DK	VU	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	4		
Basidiesvamp	Tværåret rødblad	DK	CR	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Basidiesvamp	Tvefarvet rødblad	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	3		
Basidiesvamp	Tvefarvet sneglehat	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	6		

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Bilag B

Artsgruppe	Arts navn	Truet hvor?	Rødliste	Tilbagega	Priorite	Præference	Saproxyl?	Gruppe	Zone	Skove	Match	gap?
Basidiesvamp	Tykbladet gråblad	DK	EN	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Tykbladet rødblad	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	10	5	
Basidiesvamp	Tyndstokket korkpigsvamp	DK	CR	nej	B	Nål obligat	Ej-saproxyl	Nål obligat	2	1		
Basidiesvamp	Ulden slørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	4		
Basidiesvamp	Ved-navlehat	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	2		
Basidiesvamp	Ved-posesvamp	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	4		
Basidiesvamp	Vedtragthat	DK	VU	nej	B	Løvskov	Saproxyl	Åben saproxyl	34	4		
Basidiesvamp	Vellugtende læderpigsvamp	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	31	23	
Basidiesvamp	Vellugtende læderporesvamp	DK	EN	ja	A	Løvskov	Saproxyl	Saproxyl skovart	4	2	1	gap1
Basidiesvamp	Vellugtende skælhat	DK	CR	nej	B	Løvskov	Saproxyl	Saproxyl skovart	34	1		
Basidiesvamp	Vifteblad	DK	VU	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	3		
Basidiesvamp	Vinrød parasolhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	4	5		
Basidiesvamp	Violblå fagerhat	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	7	5	
Basidiesvamp	Violblå slørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Violet køllesvamp	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	34	3		
Basidiesvamp	Violet koralsvamp	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	1	gap1
Basidiesvamp	Violetbrun duftpigsvamp	DK	CR	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	9	5	
Basidiesvamp	Violetflaget slørhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Basidiesvamp	Violetknoldet slørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	2		
Basidiesvamp	Violetkødet mælkehat	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	5	5	
Basidiesvamp	Violetstokket slørhat	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Basidiesvamp	Xenasma pulverulentum	DK	EN	nej	B	Løvskov	Saproxyl	Saproxyl skovart	4	1		
Basidiesvamp	Zone-skørhat	DK	CR	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Lav	Almindelig bogstavlav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Lav	Almindelig kantskivelav	DK	VU	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	16	10	
Lav	Almindelig lungelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	18	12	
Lav	Almindelig rødskivelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Lav	Almindelig skæglav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	23	8	6	
Lav	Almindelig slørkantlav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	24	17	
Lav	Askegrå rensdyrlav	EU anx 5 art	LC	ja	B	Løvskov	Ej-saproxyl	Åben skov	3	15		
Lav	Bark-blegskivelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	2	
Lav	Bitter prikvortelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	26	15	
Lav	Bleg blegskivelav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Lav	Bøge-kantskivelav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Lav	Bredfliget svampelav	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	1	1	
Lav	Brungrøn bægerlav	DK	VU	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	3	2	gap1
Lav	Busket skæglav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	15	7	
Lav	Elegant skållav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	0	gap2
Lav	Filtrandet kantskivelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	4	4	
Lav	Flotows hulfrugtlav	DK	CR	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Lav	Gele-skivelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	2	
Lav	Glinsende kernelav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	24	18	
Lav	Grå dugskivelav	DK	CR	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	17	13	
Lav	Grågrøn bægerlav	DK	VU	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	26	17	
Lav	Grøn bogstavlav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Lav	Grønlig porina	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	11	11	
Lav	Grønpudret bogstavlav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	3	3	
Lav	Gul trådkantlav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	10	8	
Lav	Gulgrøn bægerlav	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	1	1	
Lav	Gulgrøn kantskivelav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	3	3	
Lav	Hede-rensdyrlav	EU anx 5 art	LC	ja	B	Løvskov	Ej-saproxyl	Åben skov	3	65		
Lav	Indsænket kernelav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Lav	Kliddet bægerlav	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	38	22	
Lav	Kruset skjoldlav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	8	5	
Lav	Kvist-kantskivelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	13	6	
Lav	Lakrød bægerlav	DK	VU	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	50	32	
Lav	Liden skæglav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	10	7	
Lav	Naegelis tensporelav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Lav	Nåleprikket bogstavlav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	15	8	
Lav	Oliven-bogstavlav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Lav	Opblæst bægerlav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	5	4	gap1
Lav	Poelts væggelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Lav	Pudret bægerlav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	2	
Lav	Rendet grenlav	DK	RE	RE	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	1	1	
Lav	Rødbrun gammelskovslav	DK	RE	RE	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Lav	Rødbrun nyrelav	DK	CR	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Lav	Rosenrød stilav	DK	CR	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Lav	Ru prikvortelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	2	
Lav	Skæglav slægten	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Lav	Skælklædt bægerlav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	13	5	
Lav	Skov-punktlav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Lav	Skurvet prikvortelav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Lav	Sølv-kantskivelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	4	4	

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Bilag B

Artsgruppe	Arts navn	Truet hvor?	Rødliste	Tilbagegå	Priorite	Præference	Saproxyl?	Gruppe	Zone	Skove	Match	gap?
Lav	Soral-fuscidea	DK	VU	nej	B	Løvskov	Ej-saproxyl	Anden løvskov	34	1		
Lav	Sprække-punktlav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	4	3	gap1
Lav	Stjerne-pletlav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	17	14	
Lav	Tørve-bægerlav	DK	CR	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	1	0	gap1
Lav	Turners blegskivelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	4	4	
Lav	Tynd prikvortelav	DK	CR	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Lav	Ved-nålesvamp	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	0	gap1
Lav	Voksgul orangelav	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Lav	Vorte-blegskivelav	DK	EN	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Mosser	Almindelig hvidmos	EU anx 5 art	-	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	42		
Mosser	Almindelig tørvemos	EU anx 5 art	-	ukendt	B	Løvskov	Ej-saproxyl	Anden løvskov	34	60		
Mosser	Brodspids-tørvemos	EU anx 5 art	-	ukendt	B	Løvskov	Ej-saproxyl	Anden løvskov	34	49		
Mosser	Frynset tørvemos	EU anx 5 art	-	ukendt	B	Løvskov	Ej-saproxyl	Anden løvskov	34	51		
Mosser	Grøn buxbaumia	EU anx 2 art	-	nej	A	Løvskov	Ej-saproxyl	Anden løvskov	34	14	7	
Mosser	Trindgrenet tørvemos	EU anx 5 art	-	ukendt	B	Løvskov	Ej-saproxyl	Anden løvskov	34	20		
Mosser	Udspærret tørvemos	EU anx 5 art	-	ukendt	B	Løvskov	Ej-saproxyl	Anden løvskov	34	48		
Karplanter	Almindelig ulvefod	EU anx 5 art	LC	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	67		
Karplanter	Blåtoppet kohvede	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	1	gap1
Karplanter	Cypres-ulvefod	EU anx 5 art	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	11	5	
Karplanter	Eng-hejre	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	3	2	gap1
Karplanter	Femradet ulvefod	EU anx 5 art	LC	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	65		
Karplanter	Finsk røn	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	5	4	gap1
Karplanter	Flad ulvefod	EU anx 5 art	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Karplanter	Flueblomst	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Karplanter	Foldfrø	DK	EN	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	1		
Karplanter	Forskelligblomstret viol	DK	VU	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	2	2	
Karplanter	Fruesko	EU anx 2 art	VU	nej	A	Løvskov	Ej-saproxyl	Åben skov	3	2	1	gap1
Karplanter	Hjortetunge	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	3		
Karplanter	Hvidplettet lungeurt	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	4	2	gap2
Karplanter	Kantet kohvede	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	4	3	gap1
Karplanter	Kost-nellike	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	4	3	gap1
Karplanter	Krat-snerre	DK	CR	ja	A	Løvskov	Ej-saproxyl	Anden løvskov	34	1	1	
Karplanter	Kvast-høgeurt	DK	VU	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Karplanter	Langsporet gøgelilje	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	34	1	1	
Karplanter	Lav rapgræs	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	3	3	
Karplanter	Otteradet ulvefod	EU anx 5 art	LC	nej	B	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	38		
Karplanter	Rød hullæbe	DK	VU	nej	B	Løvskov	Ej-saproxyl	Åben skov	3	2		
Karplanter	Rød skovlilje	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	2		
Karplanter	Skærm-elm	DK	EN	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	1	1	
Karplanter	Storblomstret hullæbe	DK	VU	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	1		
Karplanter	Sværd-skovlilje	DK	EN	nej	B	Løvskov	Ej-saproxyl	Urørt løvskov	34	2		
Karplanter	Tørve-viol	DK	CR	ja	A	Løvskov	Ej-saproxyl	Åben skov	3	2	0	gap2

Bilag B. Artsdata. Detaljer om status, præferencer og zoner for de 626 skovarter.

Truet hvor?: De fleste af de internationalt truede arter er også truet nationalt, men kun den mest internationale vises

Rødliste: Global kategori for globalt truede. Dansk rødliste kategori i øvrigt (aldrig EU rødliste kategori).

Tilbagegang: Ifølge rødlistens information (for at undgå inkonsistenser noteres EU rapporterings trend ikke her).

Zone: Artens tilknytning eller præference for en eller flere af de definerede beskyttelses typer (z1= Normal, z2 = Nål, z3 = Aktiv, z4 = Urørt).

Skove: Antal statsskove med registreret forekomst af arten 1991-2015.

Match: Antal statsskove henført til en matchende zone for arten i scenarie Q. (Kun noteret for prioritet A arter).

gap_Q?: Gap mellem målet (5 repræsentationer eller 100%) og match i scenarie Q.

Skove a priori låst til zone 4 (Urørt)

Side 1 af 1

Bilag C

Enhed og skov		Areal (ha) Løv	Nål	Lysåben	Total	% skov allerede i zone 3	zone 4	MX zoner valgt	Antal arter fra hver zone gruppe z2	z3	z4	z23	z24	z34	ikke-skov	Total	Prioritet A arter Alle	Skov	% obs allerede i z3	i z4
SHL	Velling Skov	103	186	47	335	27	62	1 4		7	3	3		8	6	27	13	8	19	65
SHL	Vorsø mm.	17		45	62		100	1 4		8		1		2	6	17	10	5		100
VAD	Draved Skov og Kongens Mose	198	1	366	565		100	4		16	10	5		14	31	76	32	19		44
FYN	Kasmose Skov	11		9	20		100	3 4		3	2			10	1	16	5	5	19	20
SDJ	Midtskov	5	0	0	5		100	1 4								ingen				
SDJ	Rønhave Skov	5			5		100	1 4								ingen				
SDJ	Bolderslev Skov	109	2	46	157		100	1 3 4		5		2		2	2	11	4	4		100

Kriterier for a priori at låse til zone 4 (Urørt):

Enten 100 % af total areal urørt i forvejen OG > 5 ha skovbevokset urørt
eller > 100 ha skovbevokset urørt OG > 45% af total areal urørt

Allerede urørt inkluderer nåleskovspartier i Velling Forest, som i 1994 blev besluttet inkluderet som urørt efter en overgangsperiode til fjernelse af nål.

Skove altid i zone 4 (N = 20)

Side 1 af 1

Bilag D

Enhed og skov		Areal (ha) Løv	Nål	Lysåben	Total	% skov allerede zone 3	zone 4	MX zoner valgt	Antal arter fra hver zone gruppe z2	z3	z4	z23	z24	z34	ikke-skov	Total	Prioritet A arter Alle	Skov	% obs allerede i z3	i z4
HIM	Nørreskov	181	227	64	472	20	10	4	2	14	13	4	2	42	6	83	42	38	41	35
SHL	Dalgård	14	12	31	56			4		6	1	2		1	12	22	17	8		
SHL	Klostermølle mm.	6	7	47	60		6	4		7	1	2		5	8	23	13	8		11
KJY	Ajstrup Strand	13		10	22	56		4			1			1	1	3	2	1	67	
VAD	Draved Skov og Konge	198	1	366	565	1	46	4		16	10	5		14	31	76	32	19		44
SDJ	Søgård Skov	88	55	17	160	4	4	4		4	1	1		3	1	10	5	4	2	
STS	Klinteskov	250	2	286	538	39	24	4	1	33	32	12		55	46	179	90	53	33	37
HST	Ravneholmene	68	14	47	129	18		4		2	6	1	2	2	3	16	10	8	47	
HST	Jægersborg Dyrehave	435	8	452	895	87	3	4	1	30	30	7	1	47	31	147	83	58	87	7
HST	Ordrup Krat	17		38	55			4		1	3			4	3	11	8	6		
NSJ	Arresødal skov	63	7	15	85	61	12	4		5	7	1		4	2	19	7	6	17	43
NSJ	Esrum Møllegård	2		50	52			4		3	1			1		5	3	3		
NSJ	Gribskov	1943	1180	722	3845	11	8	4	7	28	19	16	5	45	43	163	89	70	16	26
NSJ	Søskoven	498	188	100	785	37	6	4	1	13	4	6	2	24	8	58	23	21	27	8
NSJ	Store Dyrehave	614	352	121	1087	0	1	4	1	7	10	4	3	17	12	54	23	18	2	5
NSJ	Harager Hegn	259	50	51	359	2	8	4		6	2	3	1	8	4	24	12	9		31
NSJ	Horserød Hegn	381	166	70	616	6	13	4	1	3	5	2	1	13	11	36	12	11	6	15
NSJ	Gurre Vang	146	38	258	442	9	15	4		11	2	2	1	8	13	37	9	7	26	19
OSJ	Farum Lillevang	87	7	12	106	5	2	4		3	4			5	4	16	6	3	6	46
OSJ	Store Hareskov	181	69	45	295	5		4	1	10	6	2		12	3	34	15	13		
	total	5442	2382	2802	10625															

Skove altid i zone 3 (N = 55) **Side 1 af 1** **Bilag E**

		Areal (ha)				%skov allerede		MX zoner	Antal arter fra hver zone gruppe								Prioritet A arter		%obs allerede	
Enhed og skov		Løv	Nål	Lysåben	Total	i z3	i z4	valgt	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
HIM	Gravlev ådal	4	1	114	119			3		9				1	11	21	9	4		
HIM	Navn Sø			100	100			3		5				4	15	24	12	4		
HIM	Rebild Bakker	1		107	108	100		3	1	6		1	1	1	8	18	10	5	100	
VJY	Tihøje Hede	6		210	217			3		1		1			1	3	2	1		
SHL	Østerskoven, østlige d	92	138	149	379	20	10	3	2	4		4		8	3	21	11	9	10	11
SHL	Bjørnholt	11	25	31	66	2		3	1	6					10	17	15	5		
SHL	Hulbakken		2	6	8			3		1		1				2	1	1		
THY	Hvidbjerg Plantage	108	740	835	1682		6	3	2	6		5		1	23	37	26	9		5
THY	Svinkløv Plantage	132	332	253	717			3	5	13	3	5	1	2	15	44	28	16		
KJY	Mols Bjerge	60	60	715	836	8	3	3	2	25	1	6	2	13	59	108	80	28	3	14
KJY	Hestehave Skov	126	36	51	213	1	4	3		7		3		24	23	57	45	23		8
KJY	Kalø Hovedgård		1	7	7			3		4				2	3	9	9	6		
MJY	Nørlund Plantage	112	1435	1435	2982			3	14	13		14		9	57	107	62	24		
VAD	Årup Hede			39	39			3		3		3			6	12	9	5		
VAD	Rømø Strand		2	4171	4173			3		5					26	31	19	4		
FYN	Bobakkerne			62	62			3		6					22	28	26	6		
FYN	Sollerup Skov	85	31	73	189		0	3		6	1			4	2	13	4	3		
FYN	Svanninge Bakker	51	16	254	320	0		3	1	11	2	3		4	9	30	23	14		
FYN	Rødme Svinehaver	10	1	25	36			3		6				2	10	18	10	4		
FYN	Thurø Rev			36	36			3		7					13	20	18	6		
FYN	Voderup Klint			35	35			3		7				1	8	16	12	6		
FYN	Lille Rise	2	6	2	9			3		1						1	1	1		
BLH	Skallingen			2003	2003			3		5		2			30	37	28	5		
BLH	Fanø Plantage	54	620	580	1254			3	1	9		3		4	22	39	20	7		
TRE	Skærsø	7	1	5	12			3		1				1	4	6	5	1		
TRE	Skovhave M.M.	2		15	17		9	3		2					2	4	4	2		
TRE	Ussinggård Sønder og	47	24	2	74			3		2					2	4	2	2		
TRE	Drenderup Skov	37	7	1	45			3		4						4	3	3		
TRE	Svanemosen	34	2	88	124	21	27	3		14	1	8		5	20	48	20	12	57	11
TRE	Østergård	7	1	94	102		8	3		3					3	6	5	3		
SDJ	Sønderskov	278	54	77	409	0	0	3		15	1	1		2	6	25	14	10		
SDJ	Rise Skov	90	3	31	124	3	5	3		3		1			2	6	3	2		
SDJ	Kalvø mv.	11		31	42	7	8	3		1		1		1	2	5	2	1		
STS	Hannenov Skov	144	80	89	314			3		13		1		5	9	28	14	9		
STS	Halskov Vænge	16	1	26	44	41	20	3		4						4	2	2	100	
STS	Holtug Kalkbrud			6	6			3		6		1			7	14	12	6		
BON	Almindingen	916	1097	406	2420	3	3	3	9	29	4	2	2	22	48	116	63	34	6	3
BON	Ølene	13	6	76	95	17	23	3	4	18		2		8	19	51	28	16		5
BON	Hammersholm og Han	38		169	207	15		3		17				4	35	56	48	17	6	
BON	Slotslyngen	83	12	67	162	28	30	3	1	16		4		15	25	61	43	25	37	44
BON	Borrelyngen	6	1	32	38	55	12	3	1	6		1		3	10	21	14	5	99	
HST	Strandparken	13	1	45	58			3		9	1	1		13	3	27	12	10		
HST	Kalvebod Fælled	28	0	153	182			3		2					9	11	7	2		
VSJ	Kongsøre Skov	183	29	35	247	1	1	3		5				3	1	9	6	6		
VSJ	Sonnerup Skov	66	173	49	287			3	2	9					13	24	21	9		
NSJ	Vinderød skov	32	8	28	68	19		3		7				1	2	10	8	6	89	
NSJ	Lyngby skov	51	7	9	66			3		4				3	1	8	6	5		
NSJ	Ll. lyngby mose	2	2	46	50			3	1	8	1			1	13	24	16	7		
NSJ	Grønnæsse skov	68	25	7	100			3		7				2		9	6	6		
NSJ	Præstevang	82	5	13	100	1	2	3		2				2	1	5	4	3		
NSJ	Hellebæk Skov	171	12	221	403	12	7	3		16	3	1		7	12	39	20	14	15	18
NSJ	Egebæksvang Skov	93	1	25	119	2		3		6	3			3	2	14	9	7		
NSJ	Fredensborg Skovene	10	2	0	12	88		3						2		2	1	1	100	
OSJ	Tokkekøb Hegn	409	108	113	630	7	3	3		12		5		12	4	33	22	20		7
OSJ	Ganløse Eged m.m.	129	22	16	167		2	3		10	1			2	9	22	16	8		1
	total	3918	5126	13266	22310															

Skove med variabel zone (N = 220)

Side 1 af 3

Bilag F

	Areal (ha)				skov allere		MX zoner	Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede		X zone resulta	
Enhed og skov	Løv	Nål	Lysåben	Total	i z3	i z4	valgt	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4	O3	Q5
HIM Skindbjerglund	37	1	12	50	82	12	3 4		9	5	2	1	9	1	27	19	18	75	25	4	3
HIM Præstens Plantage		17	4	21			1 2	1							1	1	1			1	1
HIM Smidie Kalkgruber			1	1			1 3		2						2					1	1
HIM Vilsted Sø	13		848	861		2	1 3		3					11	14	6	1		8	1	1
HIM Fællesskov	187	307	98	592	32	8	2 3 4	1	6	3	1		10	3	24	17	14	38	27	2	3
HIM Livø	41	20	273	334	14	11	3 4		8			1	7	11	27	16	7	43		3	3
VJY Klosterheden Plantag	847	4462	1090	6399		2	1 2 3	4	10		7		2	29	52	34	11		3	1	3
VJY Stråsø Plantage	216	760	942	1917		1	1 2	14	8		12	1	2	20	57	41	23		1	2	2
VJY Arealer ved Ferring o			73	73			1 3		1					4	5	5	1			3	3
VJY Harboøre Tange			1114	1114			1 3		4					17	21	13	3			3	3
VJY Hoverdal Plantage	115	1039	408	1562			2 3 4	12	10	2	9	1	9	30	73	43	22			2	3
VJY Fejsø Plantage	200	658	731	1588		3	1 2 3	12	5		6			10	33	22	13		13	1	2
VJY Husby Plantage	100	710	256	1066			1 2	2	7		4	1		17	31	22	10			1	2
VJY Arealer i Ringkøbing k			7	7			1 3		2					4	6	4	1			1	3
VJY Fjand Enge		4	253	257			1 3		2					9	11	8	1			1	3
VJY Vest Stadil Fjord			1108	1108			1 3		5				1	21	27	17	3			3	3
VJY Blåbjerg Plantage	91	337	375	802		1	1 3		3		4		1	7	15	8	3			1	1
VJY Sandfær	20	21	529	569		1	1 3	1	7		6			9	23	14	6		4	1	3
SHL Kobskov Øst	17	21	42	80			3 4				2		3	1	6	5	4			3	3
SHL Nordskov	191	607	188	986	17	11	2 3	20	8	2	12	2	16	16	76	55	41	13	35	2	2
SHL Snabegård Skov	27	88	20	135	10	0	1 3		4		3		6	8	21	10	7	28		1	1
SHL Velling Skov	103	186	47	335	23	54	1 4		7	3	3		8	6	27	13	8	19	65	4	4
SHL Vorsø mm.	17		45	62		77	1 4		8		1		2	6	17	10	5		100	4	4
SHL Trustrup Høje	0	2	6	8			1 3		1					1	2	2	1			1	3
SHL Naturstien Stenballe S			9	9			1 3 4			1			6		7	1	1			1	1
SHL Thorsø Bakker	31	107	34	171	9	9	1 2	1					4	1	6	1	1	6	17	1	1
SHL Sønderskov	250	205	229	684	35	3	3 4	1	2	2	4		17	6	32	18	13	59	8	3	3
SHL Himmelbjerget	49	92	13	154			1 3		1		2		1	2	6	4	3			1	1
SHL Høgdal	18	12	24	53	8	2	1 3		7				2	15	24	22	8	70		3	3
SHL Kallehave	3	21	16	39			1 3		2					6	8	7	2			1	3
SHL Odderholm	2	1	24	27			2 4	1	12	1	5		5	20	44	28	13			2	4
SHL Mariedal	0	8	33	40			1 3		1					2	3	3	1			1	1
SHL Ny Vissingkloster	24	26	39	89			1 3		6				1	9	16	14	5			1	3
SHL Lysbro Skov	39	43	67	149	7	14	3 4	2	4	1			3	5	15	8	5		13	3	4
SHL Vesterskov	184	375	94	653	29	27	3 4	3	6	7	7		16	9	48	23	18	21	40	3	4
SHL Gjern Bakker	22	2	9	33	69	14	1 3		3					2	5	4	2	80		1	3
SHL Kobskov Vest	19	4	55	77	14		3 4	1	1	1	3		9	1	16	8	7	18		3	3
VSY Læsø Plantage	375	786	714	1875	9	2	3 4	9	11	2	8		8	38	76	42	19	17	1	3	3
VSY Skagen Plantage	44	698	732	1474			2 3 4	11	9	1	11	2	4	38	76	53	24			3	3
VSY Bunken Plantage	47	484	690	1221		6	1 2 4	13	12	1	9		4	50	89	61	23		3	2	2
VSY Råbjerg Plantage	0	64	345	409			1 2	5	5		3			27	40	32	9			2	2
VSY Ålbæk Plantage	79	525	132	736		1	1 2	6	8		7			23	44	36	13		0	1	1
VSY Tversted Plantage	94	592	127	812			1 2	4	5		2	1	2	22	36	27	8			1	1
VSY Uggerby Plantage	83	427	276	786			1 2	1	6		3			25	35	25	6			2	2
VSY Lilleheden Plantage	56	233	99	388			1 2	2	5		4			14	25	19	8			2	2
VSY Tornby Plantage	42	280	237	560		14	2 3	2	7		3			27	39	30	5		6	2	2
VSY Rubjerg Plantage	1	29	28	59			2 3 4	6	1		5	2	4	4	22	14	10			2	2
VSY Slotved Skov	18	19	104	141	22	9	1 3		2					4	6	3		33	50	1	1
VSY Blokhus Plantage	52	414	701	1167			1 2	4	5		2		1	13	25	15	6			2	2
VSY Tranum Plantage	272	1408	2243	3922		4	1 3 4	2	10		5	1	1	31	50	30	10		4	3	4
VSY Hune Plantage	5	54	6	65			1 2	5	2		3			4	14	10	7			2	2
THY Lodbjerg Plantage	75	340	616	1031			1 2	1	9		4	1	3	28	46	34	10			2	2
THY Lyngby Hede		73	1196	1270		5	1 2		6		2			9	17	12	4			2	2
THY Stenbjerg Plantage, v	12	385	544	941			1 3 4		5		2		1	8	16	8	2			1	1
THY Stenbjerg Plantage, ø	88	526	317	931		9	1 3 4	1	5		6		2	11	25	20	10		4	1	3
THY Tvorup Syd	101	933	982	2016		14	1 3	2	10		4		1	24	41	28	7			1	1
THY Nystrup Plantage, øst	94	833	311	1239			1 2	7	7		7	1	3	10	35	21	12			1	2
THY Nystrup Plantage, ves	17	234	612	863			1 2	7	7		6		2	11	33	23	14			1	1
THY Vandet Plantage	88	326	30	444			1 4	4	4	1	2			4	15	8	6			1	1
THY Vilsbøl Plantage	143	473	603	1218			3 4	2	13	2	6	1	7	20	51	33	16			3	3
THY Tved Plantage	181	829	434	1444		0	2 3 4	11	9		10		5	29	64	45	20			2	2
THY Hanstholm Vildtreser		80	3208	3288		2	1 2 3	1	10		4		4	42	61	42	10		1	1	2
THY Hanstholm Kystskræn	2	5	245	252			3 4		8	2				18	28	21	6			4	3
THY Østerild Plantage	222	923	450	1595			1 3 4	3	7	1	8	1	10	19	49	25	12			1	3
THY Madsbøl Plantage	12	325	436	773			3 4	1	4		2		1	14	22	15	3			3	3
THY Lild Plantage, vestlige	71	631	584	1287		4	1 2	1	3		2	1	3	11	21	12	4		1	1	2
THY Lild Plantage, østlige	65	367	651	1083			1 2	2	6		3	1	7	38	57	34	8			2	2
THY Vester Thorup Planta	117	1059	328	1504		7	1 2 3	7	9		4	1	2	23	46	30	13		0	1	2
THY Fosdal Plantage	147	232	140	520		6	3 4	4	8	2	6		9	22	51	32	14		42	3	3
THY Slettestrand			549	549			1 3		3					9	12	7	2			1	1
THY Langdal Plantage	32	122	22	176			3 4	1	1	1	1		3		7	2	2			3	3
KJY Indskovene	276	88	461	825	13	9	2 4	2	10	2	2		9	11	36	21	13	31	20	2	2
KJY Hjermind Skov	68	113	84	265	12	3	1 2 3 4	1	3	1	2		3	4	14	6	2	2	24	1	3
KJY Lysnet			9	9			1 3		1					2	3	3	1			3	3

Skove med variabel zone (N = 220)

Bilag F

	Areal (ha)				skov allere		MX zoner	Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede		IX zone resulta	
Enhed og skov	Løv	Nål	Lysåben	Total	i z3	i z4	valgt	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4	O3	Q5
KJY Helgenæs Syd	6	29	174	209			3 4		8	2			3	14	27	21	7			3	3
KJY Dragsmur	1	2	51	53			1 3		6					20	26	22	4			1	3
KJY Ørnbjerg Mølle	9	35	53	97	37	2	1 4		3	1	1			5	10	8	3	10		4	4
KJY Gjerrild Strand	8	2	38	48			1 2	1	2		2		2	5	12	8	4			2	2
KJY Viborg Plantage	132	275	29	437		3	1 2 3		3		1		2	4	10	9	5			1	2
KJY Hald Hovedgård	221	81	201	502	6	34	3 4		8	3	2		16	9	38	24	16	12	78	3	3
KJY Stanghede	37	15	198	249	8	6	3 4		6		6	1	10	13	36	21	10	19	11	3	3
KJY Hald Sø			342	342			1 3 4		1				2	3	6	2				1	1
KJY Inderø Skov	70	3	5	78	82	63	3 4		3		3		13	2	21	11	10	46	54	3	3
KJY Ringelmose Skov	119	42	32	193		2	3 4		5	1	1		12	13	32	25	13			3	3
KJY Markerne	2	0	388	390			2 3 4	1	4				2	5	12	12	7			3	3
MJY Sønderskoven	95	640	185	920			1 2	2	4		3		1	6	16	8	2			1	1
MJY Rydhave Skov	29	1	1	31	61	30	1 3		3				2	1	6	4	3	78		3	3
MJY Mønsted Kalkgruber	2		15	17			3 4		6	2			1	4	13	6	2			3	4
MJY Alheden Skov	251	511	81	843			1 2	1	4		4		2	7	18	8	3			1	1
MJY Kompedal Plantage	243	2062	378	2683			1 2 4	5	7	1	8	1	1	14	37	25	13			1	2
MJY Haunstrup Brunkulsle	37	73	126	236			1 2	1			2			6	9	6				1	1
MJY Bøllingsø	29	26	575	630			1 2	1	9		2		3	16	31	14	4			1	2
MJY Hastrup Plantage	87	404	140	631	6	3	1 3	2	8		4	1	4	5	24	9	5		9	1	1
MJY Kilderne	86	8	362	456	16	4	1 3		9		2		8	28	47	37	11	42	7	1	1
MJY Palsgård Skov	149	720	235	1104			1 2 3 4	1	4		2		10	23	40	20	6			2	3
MJY Gludsted	181	2597	689	3467			1 2 3	8	8		10		5	22	53	33	17			1	2
VAD Hønning Plantage	120	256	148	524	10	3	1 2	3	7		1		5	10	26	14	8	9	1	1	2
VAD Lovrup Skov	179	150	54	382	32		1 4	1	4	1	2		2	3	13	4	2	35		1	1
VAD Soldaterskoven	66	31	76	173			1 3		7		2			4	13	7	4			1	3
VAD Magisterkog			227	227			1 3		6					20	26	11	2			1	1
VAD Klaskeroj Skov	73	27	18	118	11	2	1 3	1	3		1		2	2	9	5	3	18		1	3
VAD Barsbøl Skov	51	25	14	90	15	5	1 2	1	2		1		2	2	8	4	2	38		1	1
VAD Åtte Bjerge	6		25	31	86		1 3		6					2	8	1		21		1	1
VAD Stursbøl Hegn	145	244	76	465	3		1 2 3	3	7		1		2	6	19	10	5	2		1	3
VAD Lindet Skov	160	191	46	397	7	5	1 4	2	7	1	3		7	2	22	9	8	12	68	1	1
VAD Stensbæk Plantage	82	365	320	767			1 2	2	9		5	1	3	27	47	19	7			1	1
VAD Kirkeby Plantage	6	166	235	406			1 2 3	1	3		1	1	1	17	24	18	4			1	3
VAD Vråby Plantage	2	120	33	154			1 2 3	1	6			1		9	17	13	4			1	1
VAD Tingdal Plantage	11	9	9	29			1 3		4					8	12	9	3			1	3
FYN Kasmose Skov	11		9	20	44	28	3 4		3	2			10	1	16	5	5	19	20	4	4
FYN Topgården	2		25	27			1 3 4						1	2	3	3	1			1	3
FYN Frøbjerg Bavnehøj	1		10	11			1 3		1						1	1	1			1	3
FYN Flyvesandet			40	40			1 3 4	1	2	1			1	7	12	6	2			1	1
FYN Nordlangeland	308	44	38	391		1	3 4		5	2	1		2	2	12	8	6			3	3
FYN Ristinge	12	6	54	72	3		1 3		1				2	11	14	11	3			1	3
FYN Sydlangeland	106	7	333	447	9	0	3 4	2	15	2			12	21	52	35	21	53		4	3
BLH Nyminde Plantage, nc	24	255	351	630			1 3	1	5		2		3	21	32	21	4			1	1
BLH Nyminde Plantage, sy	47	541	332	920			1 2	3	4		1		4	20	32	17	5			2	2
BLH Kærgård Plantage, no	71	398	285	754		22	1 2 4	1	5	1	4		2	22	35	18	7		3	1	4
BLH Vrøgum Plantage	81	681	133	896			1 2	2	2		1		1	13	19	10	1			1	1
BLH Vejers Plantage, sydli	19	387	284	691			2 3	2	4		3		2	17	28	19	5			2	2
BLH Ål Plantage	95	377	127	599			1 3	1	6		2		1	12	22	15	4			1	3
BLH Oksby Plantage	25	431	292	748			1 2	3	3		4		1	16	27	15	5			1	1
TRE Gødding Skov	87	181	25	294			1 3 4	1	2		2		2	1	8	2	1			1	1
TRE Frederikshåb Plantag	80	504	220	804			1 3	3	9		4		1	11	28	14	6			1	3
TRE Gyttegård Plantage	34	205	252	491			1 3 4	1	9		5	1	6	37	59	36	10			4	4
TRE Randbøl Hede	0	2	710	712			1 3	1	9		3		2	33	48	27	6			3	3
TRE Grund Skov	109	25	21	154		6	3 4		6	2	1		4	1	14	10	9		2	3	3
TRE Stagsrode Skov	176	30	12	218	5	9	3 4	1	10	5	1		40	1	58	24	24	1	34	4	4
TRE Kærskov	69	14	6	89			1 2	1	2				1	1	5	3	2			2	2
TRE Skablund Skov	49	15	14	77			1 4			1			1	1	3	1				1	1
TRE Rold Skov	57	12	4	73			1 3		1		1		2		4					1	1
TRE Sønder Stenderup Mi	200	15	26	241	4	2	1 4		2	4			3		9	3	3	6	3	1	4
TRE Tapsøre Statsskov	148	15	69	232			1 3		2				1	2	5	3	2			3	3
TRE Kongens Kær			36	36			1 3		1				1	3	5	1				1	1
SDJ Nørreskov	546	68	122	736	1	7	1 3 4		6		2		9	3	20	12	10	3	6	1	1
SDJ Oleskobbel	53	2	5	59			1 3		2	1			1		4					1	1
SDJ Lambjerg Indtægt	63	2	31	96	1	1	1 3 4		2				2	6	10	5	2			1	1
SDJ Midtskov	5	0	0	5		100	1 4								none					4	4
SDJ Rønhave Skov	5			5		100	1 4								none					4	4
SDJ Dybbøl	0		198	198	0	4	1 2 4		5	1				2	8	6	4		13	4	4
SDJ Dyrehaven	83	10	18	111	4	21	1 3 4		4	3	1		6	3	17	7	4		44	1	3
SDJ Rinkenæs Skov	192	24	59	275	5	1	1 3	1	9	1			5	5	21	12	8	6		1	3
SDJ Skodsbøl Skov	60	4	24	87		5	1 3		5		1			1	7	4	3			1	1
SDJ Hønsnap Skov	62	11	10	84			1 3		3		1		5		9	5	5			1	3
SDJ Frøslev Plantage	160	538	343	1041	3		1 2	2	7		2	1	7	14	33	17	7	1		2	2
SDJ Frøslev Mose	7	0	327	335	4	1	3 4	1	10	2	2		7	34	56	26	7	3	2	3	3
SDJ Areal ved Assenholm			18	18	72		1 3 4		4				1	14	19	16	4	97		1	3

Skove med variabel zone (N = 220) **Side 3 af 3** **Bilag F**

	Areal (ha)				skov allere		MX zoner	Antal arter fra hver zone gruppe								Prioritet A arter		%obs allerede		MX zone resulta	
Enhed og skov	Løv	Nål	Lysåben	Total	i z3	i z4	valgt	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4	O3	Q5
SDJ Bolderslev Skov	109	2	46	157		100	1 3 4		5		2		2	2	11	4	4		100	4	4
SDJ Jørgensgård Skov	145	9	14	168	4	1	3 4		2	1			3	1	7	4	4	43		3	3
SDJ Lerskov Plantage	38	82	20	140			1 2	1	4			1	2	3	11	5	2			1	1
SDJ Hytterkobbel	82	42	13	137			1 3 4		3		1		3	1	8	3	3			1	3
SDJ Pamhule Skov	234	30	90	353	24	5	3 4		7				17	11	35	16	9	41	0	3	3
SDJ Østerskov	145	25	15	185	0	0	1 3		5				1	3	9	5	4			1	3
SDJ Slivsø			198	198			1 3		3				1	13	17	7	2			1	1
STS Bangsebro Skov	68	3	10	81	1		3 4		3	2			1		6	4	4			3	3
STS Bøtø Nor	9	3	100	111			1 3		8		2		3	15	28	15	5			1	1
STS Lysbro Mose ved Hejr	5		52	57			1 3 4		3	1				1	5	2	1			1	1
STS Ulvshale Skov	90	13	308	410	5	23	2 4	2	17	5	6	1	13	36	80	35	20	1	47	2	4
STS Kongskilde	37	2	285	324			3 4		14	6			7	12	39	15	10			4	4
STS Hørhaven	0		44	45			1 3		3				1	1	5	1	1			1	1
STS Dybsø			136	136			1 2	1	2				1	12	16	13	3			1	2
BON Kilen	6		1	7			1 2	1					1		2					1	1
BON Blykobbe Plantage	86	86	32	204	6	18	2 4	3	5	1	4		2	4	19	11	8	4	11	2	2
BON Ejendommen Lassen	1	6	6	12			1 3							1	1	1				1	3
BON Pedersker Skov	44	6	38	87			1 3		3						3	2	2			1	1
BON Hammerknuden	23	5	170	197	51		2 3	2	17		6		7	32	64	38	15	75		2	2
BON Del af Ringebakkerne			22	22			1 2		6		1		1	4	12	9	6			2	2
BON Tuleborg	7	1	10	18			1 4		1	1				1	3	1	1			1	1
BON Rø Plantage	213	320	60	593			2 3 4	6	11		1		5	6	29	12	8			3	3
HST Jægersborg Hegn	426	32	96	554	15	1	3 4	1	17	13	7		22	18	78	43	34	10	15	3	4
HST Søllerød Kirkeskov	36	3	9	47			3 4		1	1		1	10	1	14	8	7			3	3
HST Geel Skov	145	39	9	193			2 3 4	1	6	5		2	7	1	22	13	12			4	4
HST Enrum Skov	18	1	12	30			1 3				1		2	1	4	3	2			1	3
HST Rygård	11	0	150	162			1 4		4	2			2	3	11	7	4			1	1
HST Charlottenlund Skov	51		24	75	13		3 4		2	2		1	2	2	9	6	4	6		3	3
HST Kongelunden	208	49	74	331			3 4	1	16	2	2	1	10	16	48	28	16			3	3
HST Vestamager	236		1730	1966	7	2	3 4		16	4	3		7	41	71	40	17	16	0	3	3
HST Folehave	185	18	60	263			1 2 3	1	3	1			2	1	8	4	4			3	3
HST Rude Skov og Frihede	321	120	130	571	19	8	1 2 4	2	11	4	5	3	18	9	52	22	18	10	12	1	2
HST Vestvolden	1		289	290			3 4		7	2	1		6	3	19	9	7			3	3
VSJ Rørvig Sandflugtsplan	34	136	36	206			1 2	4	1			2		6	13	8	4			1	2
VSJ Korshage	10	7	60	76			1 2 3		3		1	1	1	13	19	15	2			1	2
VSJ Hov Vig	9	16	241	266			1 4		12	1	1		6	24	44	25	9			1	1
VSJ Høve Skov	24	8	8	40			1 2	2	1					1	4	3	2			2	2
VSJ Kårup Skov	51	93	26	170			1 2	2	4			1	1	14	22	18	5			1	2
VSJ Sanddobberne	12	0	61	73		18	1 3 4		2				1	7	10	8	3			3	3
VSJ Røsnæs	22	8	166	196			2 3 4	1	14	4	2	2	11	30	64	37	14			2	2
VSJ Diesbjerg			3	3			1 3		2					20	22	22	2			1	3
VSJ Bidstrup Skovene	646	195	181	1021	2	2	3 4	1	15	6	6	4	25	20	77	33	28	5	4	4	3
VSJ Myrdeskov	47	6	2	55			3 4		2	1			3		6	3	3			3	3
VSJ Boserup Skov	168	26	29	224	13	6	3 4		10	11		1	20	2	44	20	19	29	3	3	4
VSJ Hyrdehøjskoven	30	5	18	53			1 4		5	2			1		8	4	4			1	1
NSJ Sonnerup Skov	45	12	3	60			1 3		4				1	3	8	6	3			3	3
NSJ Arresø	19		4102	4121			1 4		9	1	1		5	9	25	12	8			1	1
NSJ Tisvilde hegn	338	1280	375	1992	0	6	2 3 4	25	30	12	16	6	37	66	192	113	63		1	2	2
NSJ AP-Møllergrunden	2	1	7	9			1 3 4						1	9	10	7				1	1
NSJ Aggebo og Græsted H	144	24	20	188			1 4		2	1	1	3	6	1	14	9	9			1	1
NSJ Freerslev hegn	210	30	35	275	9	4	1 3 4		6	1			3	1	11	7	6	9		1	1
NSJ Stenholt Vang	198	81	35	313		8	1 2 3	2	3		3	1	6	3	18	6	4		5	1	2
NSJ Esrum Sø			1734	1734			1 3		5				4	9	18	7	4			1	3
NSJ Nakkehoved	5		23	28			1 3		2				2	5	9	7	3			3	3
NSJ Hornbæk Plantage	105	71	22	198			2 3 4	3	1	1	4	2	6	4	21	10	7			2	3
NSJ Teglstrup Hegn	306	138	100	544	26	18	3 4		8	3	4	1	18	22	56	22	14	57	4	3	4
NSJ Klosterris Hegn	204	122	27	353			1 2 3	1	2	1	3		5	3	15	2	2			1	1
NSJ Nyrup Hegn	109	103	30	242	1	6	3 4	2	6	1	1	1	5	1	17	7	7		3	3	3
NSJ Danstrup Hegn	197	78	50	325	0	1	1 2	1	8		1	1	8	6	25	10	6			1	1
NSJ Krogerup Skovene	64	6	154	223	2		1 3		1	1	1		2	2	7	5	3			1	1
NSJ Lave Skov og Stejlepla	63	1	5	68	7		1 3		1				1		2	1	1			1	1
OSJ Ryget	115	21	14	149	17	30	3 4		4	3	3	1	13	16	40	17	12	3	82	4	4
OSJ Nørreskoven	169	11	13	194	12	9	1 3 4		4	13	1		20	1	39	10	9	12	34	4	4
OSJ Furesø			932	932			1 3 4		4	1			9	6	20	9	5			1	3
OSJ Terkelskov	38	3	14	54	45	44	3 4		10	2			8	5	25	14	9	19	21	3	3
OSJ Ganløse Ore	216	150	30	396		1	2 4	2	7	2		1	10	3	25	16	13			2	4
OSJ Bøndernes Hegn	55	6	25	85			1 3 4		9	2	1		4	3	19	8	6			1	3
OSJ Lille Hareskov	110	28	21	159	7	0	1 4		6	2			7	2	17	7	6			1	1
OSJ Jonstrup Vang	174	27	38	240	11	5	3 4		13	5	1		9	8	36	20	13	6	1	4	4
OSJ Vestskoven	556	183	604	1342			2 4	1	9	4	2	3	8	17	44	28	17			2	4
OSJ Ravnsholt	150	123	40	312	1	0	3 4		10	1	1	1	7	3	23	14	12	15		4	4
OSJ Slagslunde skov	188	17	19	224	1	3	1 3 4		2	4			3	6	15	11	5		3	1	4

Skove altid i zone 1 (N = 681)

Side 1 af 11

Bilag G

		Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede	
Enhed og skov		Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
HIM	Svalebakken			2	2									1	1				
HIM	Stenholmen			1	1										O				
HIM	Julstrup Sø	7	3	82	92				2		1			4	7	3	1		
HIM	Øer ved Hals			8	8										O				
HIM	Lille Ravnkilde			1	1										O				
HIM	Rebstrup			1	1										O				
HIM	Vrå Mølle	0	1	7	8										O				
HIM	Blåkilde Dambrug			5	5										O				
HIM	Dokkedal	2		2	3				2					4	6	5	1		
HIM	Mosskov	133	320	173	625	16	5		5		1		9	8	23	16	9	50	4
HIM	Halkær Mølle			52	52				1					8	9	6	1		
HIM	Naturstien Nibe-Hau			45	45				1					1	2	1			
HIM	Vokslev Kalkgrav	2	0	4	6		31								O				
HIM	Aars Skov	104	68	49	221				1						1	1	1		
HIM	Drastrup Skov	209	42	121	372				1					6	7	6	1		
HIM	Nørager	42	17	18	77								1	1	2	1			
HIM	Poulstrup Skov og K	8	1	38	47				4					2	6	5	3		
HIM	Sct Nicolai Bjerg vec			5	5								1	6	7	5			
HIM	Arden Skov	2		22	24										O				
HIM	Østre Banevej Skov	41	120	72	233	3	4		2		1		6	4	13	9	5	2	37
HIM	Hyllebjerg	0		6	6										O				
HIM	Grønnerup Strand	0	0	5	5										O				
HIM	P-plads ved Svingelt			1	1										O				
HIM	Lille Skovsgårds Hag			2	2										O				
HIM	Lundshøj	4		7	11		39						1	3	4	4	1		25
HIM	Als Havbakker			12	12									2	2	2			
HIM	P-plads ved Als Odd				0										O				
HIM	Muddermarens Ø			1	1										O				
HIM	Pletten			16	16									1	1	1			
HIM	Jenle Plantage	14	68	10	92			1			1			1	3	1	1		
HIM	Plovmandshøj Plant	20	68	3	90				1						1				
HIM	Frendrup hede - Vol	2		11	13									1	1				
VJY	Rønland Sandø			3	3										O				
VJY	Gørding Havn			1	1										O				
VJY	Skærum Mølle	19	4	67	90									2	2	1			
VJY	Langerhuse			0	0										O				
VJY	Sønderholmene og I			140	140				1					2	3	3	1		
VJY	Høfde 8			4	4										O				
VJY	Arealer ved Fjaltring			92	92									2	2	1			
VJY	Bøvling Klit			44	44									1	1	1			
VJY	Rammedige			16	16										O				
VJY	Femhøjsande	8	28	2	38										O				
VJY	Øster Lem Hede			86	86									1	1				
VJY	Nørre Vium Brunkul	27	10	11	48						3			1	4	1			
VJY	Troldhede Brunkulsl	15	19	24	58				1		2			2	5	2			
VJY	Ahlergaarde Brunku			6	6										O				
VJY	Lystbæk	26	71	239	336				1		1			9	11	8	1		
VJY	Rejkær Hede			45	45				2					1	3	2	1		
VJY	Arealer i Holmsland			297	297				3					6	9	6	2		
VJY	Feldsted Kog			1483	1483									14	14	9			
VJY	Skårmose Plantage	30	60	29	119									1	1	1			
VJY	Ølgryde Plantage	75	273	64	413		7				2		1	1	4				
VJY	Døes Højene			16	16										O				
VJY	Møborg Skov	45	60	49	154						2			1	3	1			
VJY	Storåen,Naur			7	7										O				
VJY	Naturskolen Kærgår			3	3				1						1	1	1		
VJY	Resenborg Plantage	19	4	2	26				2					1	3	2	1		
VJY	Birkild Hede			7	7									1	1				
VJY	Livbjerggård Strand			6	6										O				
VJY	Grisetå Odde			7	7									1	1	1			
VJY	Plethøj	10	0	5	15										O				
VJY	Bøløre Odde			2	2										O				

Skove altid i zone 1 (N = 681) **Side 2 af 11** **Bilag G**

	Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede	
Enhed og skov	Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
VJY Søndbjerg Strand	2	1	2	5									2	2	2			
VJY Odby			2	2										O				
VJY Skalstrup Skov	40	95	6	141										O				
VJY Åbjerg Skov	31	66	55	152				1					1	2	2	1		
VJY Harpøth Bæk og Dai			4	4										O				
VJY Nees Sandø			3	3										O				
VJY Toftum Bjerge og Je	2	0	21	23									2	2	2			
VJY Gejlgård Bakke			0	0										O				
SHL Arealer ved Skæring	1		9	9									3	3	1			
SHL Ajstrup Strand Og N		0	19	19				2					1	3	3	2		
SHL Areal ved Brabrand			0	0										O				
SHL Stendysse ved Orms				0										O				
SHL Kollens Mølle	2		1	3										O				
SHL Bærmose- Himmeri	132	25	58	215				1					3	4	2	1		
SHL True Skov	260	36	147	443				1					1	2	2	1		
SHL Hvinningdal Skov	49	45	53	147									1	1	1			
SHL Solbjerg Skov	94	4	32	129									1	1	1			
SHL Anebjerg Skov	71	4	36	111				4					1	5	3	2		
SHL Geding Skov	18	3	7	28				1						1	1	1		
SHL Rugballegård Skov	61	12	33	106										O				
SHL Arealer i og ved Bryı			12	12										O				
SHL Illerup Ådal			32	32				1					1	2	1			
SHL Opholds- og stiareal	0		7	7				1						1				
SHL Areal ved Solbjerg S			8	8										O				
SHL Ring Kloster			1	1				1				1		2	1	1		
SHL Fårbjerg			4	4				2					5	7	6	1		
SHL Naturstien Horsens-			84	84										O				
SHL Slaggård Banke			2	2									2	2	2			
SHL Tunø og småøer	1	1	33	35									1	1				
SHL Arealer på Samsø	6	3	321	329				4					20	24	20	2		
SHL Meden Kirkeruin				0										O				
SHL Kysing Strand			6	6								1		1				
SHL Hølken Strand			10	10										O				
SHL Spøtterup Strand			2	2										O				
SHL Hou Strand			1	1										O				
SHL Hundslund-Åkjær na			10	10				1						1	1	1		
SHL Mosevej			0	0										O				
SHL Lovdal Skov	7	24	3	33		4								O				
SHL Østre Stenhule	24	28	16	68	4	27								O				
SHL Alling, vestlige del	4		4	8										O				
SHL P-plads syd for Allin			0	0										O				
SHL Arealer ved Masken	0	0		1										O				
SHL Areal ved Knudsø sy	1		3	4										O				
SHL Knudhule Strand	1		18	19										O				
SHL Vestbirksøerne	1	0	58	59				3					2	5	4	2		
SHL Mossø Brå	1		31	32									2	2	1			
SHL Bryggebjerg				0										O				
SHL Birkhede	1		6	8									1	1				
SHL Øm Kloster			0	0										O				
SHL Pindals Mose	1		0	1				2						2	2	2		
SHL Vilholt			1	1										O				
SHL Siim Skov	26	10	11	47				2						2	1	1		
SHL Østerskoven, vestlig	9	7	2	18	55					1				1	1	1	33	
SHL Sminge kanolejrplac			1	1										O				
SHL Anderiet mm.	1		4	5									1	1	1			
SHL Bøsmølle Bro			0	0										O				
SHL P-plads ved Nebel B			0	0										O				
SHL Trækstien			16	16									1	1	1			
SHL Sorring				0										O				
VSY Nordmarken			57	57			3	2					3	8	6	3		
VSY Danzigmand og Bløc	3	1	98	102				2					2	4	3	1		
VSY Vesterø Sønderland	0	3	347	349				3		1			14	18	13	2		

Skove altid i zone 1 (N = 681)

Side 3 af 11

Bilag G

	Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede	
Enhed og skov	Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
VSY Rønnerne	14	8	677	700				2					10	12	10	1		
VSY Borfeld			0	0									2	2	1			
VSY Hvide Fyr			0	0										O				
VSY Byfogedskoven	6	2	2	10								1		1				
VSY Skiverbakken			77	77				3					18	21	17	1		
VSY Skiveren Plantage	1	10	14	25				2		1				3				
VSY Tversted Rimmer	8	47	106	161				4					9	13	11	2		
VSY Råbjerg Mose			196	196			1	4					11	16	11	2		
VSY Videslet Engen			13	13				1					6	7	5			
VSY Hirsholmene			48	48									8	8	4			
VSY Areal ved Hulsig		2	12	14										O				
VSY Tversted Klit	1		36	37									3	3	3			
VSY Nejst Plantage	10	30	1	41										O				
VSY Kærsgård Strand			45	45				1					16	17	15	1		
VSY Lien Skallerup			6	6										O				
VSY P-plads ved Skalleru			0	0										O				
VSY Areal ved Lønstrup			1	1										O				
VSY Mårup Kirke			0	0										O				
VSY Rubjerg Knude Fyr			3	3										O				
VSY Kajholm	20	11	15	46										O				
VSY P-plads ved Kodal			0	0										O				
VSY Hjørring-Astrup sko	12	3	61	77										O				
VSY Måstrup Mose			1	1										O				
VSY Mosbjerg	5	2	48	55				10		1		2	8	21	11	4		
VSY P-plads ved Åsted Å				0										O				
VSY Areal ved Sulbæk			4	4										O				
VSY Solsbæk Strand		2	36	38				1					3	4	2			
VSY Søheden Skov	14	2	16	31		17								O				
VSY Slettingen	4	0	36	40		45							2	2	1			
VSY Nybæk Plantage	16	51	49	116				1					3	4	3			
VSY Munkens Klit			32	32				2					1	3	3	2		
VSY Lille Norge	4	2	31	36				3					6	9	7	2		
VSY Fårup Klit	18	24	12	53										O				
VSY Pirups Hvarre		4	29	33										O				
VSY Grishøjgårds Krat	4		161	165				5		3			10	18	10	4		
VSY Gjøl Bjerg			3	3										O				
VSY Store Vildmose			869	869				3		1		2	5	11	2	1		
THY Agger Tange			765	765				5		3			17	25	17	5		
THY Egebjerg			8	8									1	1				
THY Aaby Skoven	28	4	33	65				1						1	1	1		
THY Rønhede Plantage	44	51	7	102				1						1	1	1		
THY Fjordholmene			4	4										O				
THY Ydby-Nygård Planta	2	0	8	10				1					1	2	1	1		
THY Hurup Golfskov	13	1	0	14										O				
THY Faddersbøl	12	13	13	38										O				
THY Sundby Sø			83	83									1	1	1			
THY Øer omkring Mors			7	7										O				
THY Ejerslev Vang			12	12				1					2	3	3	1		
THY Areal ved Hanklit			4	4										O				
THY Buksør Odde			39	39				2					2	4	3	2		
THY Legind Vejle	1		77	78				1					3	4	4	1		
THY Tissing Vig			93	93									5	5	2			
THY Arealer Ved Søndre			132	132								1	1	2	1			
THY Tvorup Nord	29	455	67	552			1	1		3		1	9	15	7	1		
THY Vangså Hede		5	618	623				5		1			16	22	13	2		
THY Snedsted Byskov	3	0		3										O				
THY Kronens Hede Plant	5	172	19	196		9		2					6	8	6	1		
THY Bavn Plantage	18	11	9	38									2	2	2			
THY Sjørring Volde	2		1	3										O				
THY Arealer ved Langdys			1	1										O				
THY Eshøj	6	1	2	8										O				
THY Hanstholm Byplanta	27	48	46	121									6	6	5			

Skove altid i zone 1 (N = 681) **Side 4 af 11** Bilag G

	Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede	
Enhed og skov	Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
THY Vigsø rallejer			340	340			1	5					9	15	9	3		
THY Vigsø og Ballerum P	47	160	80	286			1	1					5	7	6	1		
THY Korsø Plantage	55	356	434	845			1	1					7	9	5			
THY Hjardemål Plantage	61	707	388	1156		11	2	6		3			21	32	19	4		35
THY Tømmerby Kær	4	134	115	254				1					2	3	2			
THY Areal ved Selbjerg V			1	1										0				
THY Frøstrup Skov			9	9										0				
THY Aggersborg			10	10										0				
THY Kollerup Plantage	41	254	185	479			2	3		6			7	18	11	5		
THY Hingelbjerg	0	0	3	3										0				
THY Hingelbjerg Mose			0	0										0				
THY Husby Hole			0	0										0				
THY Bredkær Plantage	9	27	1	37										0				
KJY Udskovene	201	136	14	350	20	4		2				2		4	3	3		
KJY Randers Nørreskov	10			10										0				
KJY Randers Nordre Fæl	44	3	93	140										0				
KJY Vindum Skov	161	116	47	324	27	2		2		1		2	3	8	4	2	33	
KJY Busbjerg	2			2										0				
KJY Frisenvold Laksegår	1		135	135		3							4	4	3			
KJY Frydensbjerg og Kat	4		10	15				2				1	9	12	9	1		
KJY Hohøj Arealer			2	2										0				
KJY Hadsund Bane			9	9										0				
KJY Mosely	11		21	32				3					2	5	4	2		
KJY Hærup P-plads			0	0										0				
KJY Ulbjerg Klint			24	24									2	2	2			
KJY Sundstrup Arealern			20	20									1	1	1			
KJY Rønnen			0	0										0				
KJY Bjødstrup Strand			3	3										0				
KJY Karpenhøj	1	0	48	49				1					4	5	5	1		
KJY Vænge Sø			49	49				2					5	7	4			
KJY Mågeøen			10	10										0				
KJY Areal ved Stubbe Br	3		4	7								1		1				
KJY Natursti Ebeltoft-Gr			14	14								1		1				
KJY Vibæk Strand			0	0										0				
KJY Holme strandareale			10	10									3	3	3			
KJY Hyllested Bjerge	3	9	27	39	98					1				1			100	
KJY Bisballe-Almind	12	15	105	132	20	1		1				1	7	9	7	1	11	
KJY Bruunshåb	1		3	3										0				
KJY Klostermarken	27	2	46	75				1					8	9	8			
KJY Klokkerholm Skov	24	4	5	32									1	1				
KJY Randers Sønderskov	24	5	10	39				1						1	1	1		
KJY Øer i Randers Fjord			3	3										0				
KJY Elløv Enge	2		26	27										0				
MJY Borbjerg-Nørreskov	453	1662	262	2376			3	7		4		1	2	17	10	9		
MJY Sjørup Skov	82	208	42	331									1	1	1			
MJY Arealer på Nordfur	5	7	87	98				2					3	5	4	1		
MJY Jenle	7	1	31	38	6	13								0				
MJY Brokholm Sø	1		141	143				3					2	5	3	2		
MJY Havbjerg Skov	42	43	62	146				1					3	4	3	1		
MJY Vinderup Skov	58	24	89	171									1	1	1			
MJY Geddal Strandenge			126	126				1					10	11	5	1		
MJY Spøttrup Sø	1	1	113	114				1					1	2	2	1		
MJY Arealer på Lundø			12	12										0				
MJY Egekrat ved Aulum	3			3		100								0				
MJY Småarealer Salling	3		24	27										0				
MJY Grynderup Sø		1	78	79				1					1	2	1			
MJY Arealer ved Durup			1	1										0				
MJY Løvbakke Skov	101	39	46	186				2					1	3	3	2		
MJY Areal ved Rabis			63	63									2	2	1			
MJY Ikast Byskov	60	15	20	94				1					1	2	2	1		
MJY Søby Brunkulslejer	23	129	215	366			1	4		5			6	16	8	3		
MJY Funder-Ejstrup natu	13	5	55	72									4	4	2			

Skove altid i zone 1 (N = 681)

Side 5 af 11

Bilag G

	Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede	
Enhed og skov	Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
VAD Råbjerg Plantage	40	61	15	117	21	15		1						1	1	1		
VAD Renbæk Plantage	67	94	44	205			1	4				1	3	9	3	1		
VAD Arrild Plantage	13	50	7	69				1						1				
VAD Nørreskov	12	1	16	29									1	1	1			
VAD Gasse Høje			2	2										0				
VAD Nørresø og Hestholı			94	94				2					13	15	8	2		
VAD Haraldsholm Skov	72	52	5	129			1					1		2				
VAD Jelssøerne			89	89				3		1		1	3	8	5	3		
VAD Sidekanal ved Lintru			1	1										0				
VAD Parceller i Sømose c			2	2									1	1	1			
VAD Jættestuer ved Over			1	1										0				
VAD Skrydstrup Skov	12	2		13										0				
VAD Lindet Mose			31	31		100		1					1	2	1			100
VAD Mandbjerg Skov	43	1	14	58	58	14								0				
VAD Varming og Nørbæk	99	296	63	458		3	1	4		1			2	8	2	2		8
VAD Toftlund Skov	48	2	12	62	16			1					1	2	1		50	
VAD Dankirke		0	4	4										0				
VAD Bevtoft Plantage	44	134	14	191			1	4		1			1	7	3	2		
VAD Gammelskov	4		11	15									1	1	1			
VAD Bjerreskov	59	18	34	112									1	1	1			
VAD Favrholt Skov	7	2	1	10										0				
VAD Tange Bakker	10	10	41	60				1		2			7	10	4	2		
VAD Tange Enge			3	3										0				
VAD Tvismark Plantage	2	60	240	302				1		1			10	12	10	2		
VAD Vestergårde Bjerge			11	11									2	2	2			
VAD Albatros			1	1										0				
VAD Klægtagningsarealeı			67	67				1					7	8	5	1		
VAD Arealer ved Husum			2	2									1	1	1			
VAD Areal på Mandø			50	50									9	9	5			
FYN Røjle Klint			2	2										0				
FYN Fortidsminder			2	2										0				
FYN Småøer		0	31	31				1					6	7	3	1		
FYN Vestermose Skov	33	1	12	46									1	1	1			
FYN Holmeskoven	18	2	4	25										0				
FYN Klakkebjerg	5	2	27	34				2		1			3	6	4	2		
FYN Arealer ved Vissenb	1		14	15										0				
FYN Feddet			72	72				2					6	8	6	1		
FYN Helnæs Made	2		248	250	1			3				4	11	18	11	3		
FYN Nørreby Hals			32	32										0				
FYN Fuglsanggård	22		9	31										0				
FYN Otterup Byskov	22	1	10	33				1						1	1	1		
FYN Fjordmarken			63	63				2				1	5	8	5	2		
FYN Vigelsø	24		108	132				1					4	5	2	1		
FYN Kirkendrup Skov	64	7	79	150				1					1	2	2	1		
FYN Elmelund Skov	132	15	124	270				1						1	1	1		
FYN Fyns Hoved	2		46	48				3				2	9	14	10	3		
FYN Bogensø Strand			7	7						1			2	3	3	1		
FYN Lods Huse			2	2										0				
FYN Lærkedal	22	3	29	54				2				1	1	4	3	2		
FYN Sønderskovgård	14	29	6	49										0				
FYN Storelung			2	2									2	2	2			
FYN Ringe Skov	101	5	63	169				1						1	1	1		
FYN Naturstien Ringe - K			23	23										0				
FYN Trente Mølle	9	10	15	33				4		1		1		6	3	3		
FYN Lyø	6	1	9	16				1					1	2	1	1		
FYN Avernakø			13	13				1					2	3	2	1		
FYN Tåsinge Vejle			35	35				2				1	5	8	6	2		
FYN Vorbjerg	9		2	11										0				
FYN Borgnæs	17		12	29								1		1				
FYN Gråsten Nor	5	8	68	81										0				
FYN Toftegårdsskoven	13		3	16									1	1	1			
FYN Egehovedskoven	13	8	10	32										0				

Skove altid i zone 1 (N = 681) **Side 6 af 11** **Bilag G**

	Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede	
Enhed og skov	Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
FYN Hov Østerland	0		7	7										0				
FYN Rudkøbing Fredskov	18		7	24				1						1				
FYN Humble Byskov	23	3	8	34										0				
FYN Næs	4			4	100									0				
BLH Blåbjerg Plantage	124	806	467	1396	1	8	2	6		6		1	21	36	23	6		
BLH Nørre Nebel Skov	100	17	46	163				2					3	5	5	2		
BLH Golfbane			37	37										0				
BLH Oversigtsareal ved H			0	0										0				
BLH Årgab			2	2										0				
BLH Bavnebjerg			154	154				1					6	7	5	1		
BLH Havrendingen			91	91									1	1				
BLH Bjergeborg			33	33									1	1	1			
BLH Bjerregård		8	28	36										0				
BLH Holmsland Klit			154	154									5	5	5			
BLH Tipperne			689	689				3				1	17	21	11	2		
BLH Klægbanken mm.			67	67									6	6	3			
BLH Præstens ø og Tykrå			3	3										0				
BLH Polde			4	4									2	2				
BLH Øer i Nymindestrøm			112	112									7	7	4			
BLH Skjern Å	3	2	1963	1967				4		1		2	29	36	21	2		
BLH Lønborg Hede			344	344				3				1	14	18	13	1		
BLH Kærgård Plantage, s	3	192	412	608			1	2		2			17	22	13	3		
BLH Vejers Plantage, nor	30	358	305	693			1	4		1			13	19	13	3		
BLH Sig kapelbanke			3	3										0				
BLH Bordrup Plantage	45	625	185	856			1	3		1			15	20	16	3		
BLH Ho Plantage	26	302	95	423			2	2		1			12	17	13	2		
BLH Langli			100	100				2				1	17	20	12	2		
BLH Fyrpasserboligen			0	0										0				
BLH Hafniagrunden			11	11				1					1	2				
BLH Oles Dige			1	1										0				
BLH Lodder Øst for Oksb			11	11									1	1	1			
BLH Kikkebjerg Plantage	1	27	8	36				1					1	2	1	1		
BLH Torp	2	3	3	8										0				
BLH Sønderho			1	1										0				
BLH Søren Jessens Sand			93	93										0				
BLH Trinden og Keldsanc			54	54										0				
TRE Engelsholm Skov	65	19	64	147	20	0							1	1	1			
TRE Tykhøj Krat	24	55	7	86	7			1		1				2	1	1		
TRE Refstrup Skov	26	1	1	27										0				
TRE Nørup Plantage	9	2	0	11										0				
TRE Vingsted Mølle	12	0	23	35				1				1	1	3	2	1		
TRE Randsfjord Arealer	10	0	30	40		3		2		1		4	2	9	5	5		
TRE Vognkær Enge og H	8	0	27	35									1	1	1			
TRE Børkop Vandmølle	1		6	8									1	1	1			
TRE Fårup Skov	7		3	10										0				
TRE Fire Høje			3	3										0				
TRE Sophienlund	9		1	10										0				
TRE Haltrup Hede		13	48	61									3	3	3			
TRE Troldhedebanen Ve			3	3										0				
TRE Eg Rasteplads			2	2										0				
TRE Tirsbjerg Plantage	11	12	1	24						1				1				
TRE Bjerge Skov	215	43	25	282		4		5		1		3	3	12	6	5		16
TRE Tønballegård	25	23	23	71	9			3						3	2	2		
TRE Bankehave	54	9	6	69				2						2	2	2		
TRE Boller Nederskov	122	19	15	156	8	2		3				2		5	2	2	22	
TRE Boller Overskov	55	1	2	59				1					1	2				
TRE Klokkedal	54	5	5	63	14	5		2				1	1	4	2	1	48	
TRE Ustrup Bjerge	17	9	1	28										0				
TRE Dybdal	16	6	1	22									1	1	1			
TRE Dallerup Skov	51	6	7	63				2				1	1	4	3	2		
TRE Lystrup Skov	27	7	2	36										0				
TRE Borringholm			2	2										0				

Skove altid i zone 1 (N = 681) **Side 7 af 11** **Bilag G**

	Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arter		%obs allerede	
Enhed og skov	Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
TRE Sebberup Skov	92	7	42	141				1					1	2	1			
TRE Sønder Stenderup N	331	51	30	412	6	1		4				2	5	11	6	3	2	
TRE Stenderup Hage			3	3										0				
TRE Sønder Stenderup S	144	22	27	193	14	5		6		1		4	2	13	4	4	8	10
TRE Skibelund			7	7										0				
TRE Grønninghoved Stra	17	1	0	18	100									0				
TRE Vargårde Skov	41	5	5	50	14	1								0				
TRE Trommersgård Skov	22	2	4	28	9			1						1	1	1		
TRE Fovslet Skov	199	48	14	260	6	3		6				3	1	10	5	5		3
TRE Hoppeshuse	59	8	100	167				1						1	1	1		
TRE Harte Skov	103	58	78	240		2		6					4	10	8	5		
TRE Troldhedebanen			17	17				2					4	6	4	1		
TRE Rastepladser ved Ny			4	4									1	1	1			
TRE Hakonsminde			5	5										0				
TRE Søballegård	1		19	20		3		1						1	1	1		
TRE Tørrepladsen	0		0	1									1	1	1			
TRE Klingebæk	4		14	18									4	4	4			
TRE Ravning Enge			6	6										0				
TRE Bindeballe Station			0	0										0				
TRE Troldhedebanen Syd			8	8										0				
SDJ Karholm	3		0	3	100									0				
SDJ Øvelgunde Fredskov	21		1	22										0				
SDJ Fryndesholm	35		2	36										0				
SDJ Græskobbel	4			4		100		1						1				100
SDJ Blommeskobbel	35	1	7	42		4		3				2		5	2	2		
SDJ Rumohrsgård Dyreh	21	7	4	32				1				1	1	3	2	1		
SDJ Ketting Nor			65	65				3				1	4	8	5	2		
SDJ Oldenor	4		44	48				2				1	1	4	2	1		
SDJ Augustenborg Skov	28	1	2	31	100			2				2		4	1	1	100	
SDJ Made Skov	17		2	20	22	13		2						2	1	1	75	
SDJ Arnkil Skov	61	0	44	106		5		8				1		9	5	5		
SDJ Arnkil Maj	10		2	12										0				
SDJ Fredskov	8	4	1	13		13		1						1	1	1		
SDJ Mjang Dam			128	128				2					4	6	4	2		
SDJ Hartsø Strand			4	4								1	1	2	2	1		
SDJ Nydam Mose			3	3										0				
SDJ Roden Skov	115	7	23	145	4	4		1					2	3	3	1	17	17
SDJ Adsbøl Dam	2		2	4	98								1	1	1		100	
SDJ Sø- og Lystskovareal	10		64	75	10	10		3				3	5	11	6	3		27
SDJ Over- og Nederstjer	30	1	4	34	2			1						1				
SDJ Buskmose Skov	59	2	21	82				1					1	2	2	1		
SDJ Avnbøl Sned	39	4	1	44										0				
SDJ Bøffelkobbel	14		1	14										0				
SDJ Skelde Folekobbel	27	1	2	30		12		1						1	1	1		
SDJ Skelde Kobbelskov	63	3	7	73		1		4	1			1		6	2	2		
SDJ Opholdsarealer ved			1	1										0				
SDJ Helligsø			15	15									1	1	1			
SDJ Nybøl			7	7										0				
SDJ Arealer ved Strande	1		0	1										0				
SDJ Kelstrup Fredsskov	53	8	7	68				1				2		3	2	2		
SDJ Kelstrup Plantage	147	130	54	331		3	1	5		2		1	1	10	3	2		
SDJ Rode Skov	16	18	36	70				5		2		1	3	11	6	3		
SDJ Kiskelund Plantage	29	26	9	64				4		1		1	1	7	4	3		
SDJ Kollund Skovholm	2			2										0				
SDJ Kruså Skov	14	1	2	17		97		1					1	2	1			75
SDJ Mølleskov	3		1	4	15	68							1	1	1		100	
SDJ Store Okseø			8	8										0				
SDJ Gårdbæk Skov	16	2	2	20				2						2	1	1		
SDJ Waldeck Skov	3	1	1	5										0				
SDJ Rønshovedskovene	14		0	14				2						2	1	1		
SDJ Gammelmose Skov	11	3	18	32										0				
SDJ Lyreskoven	23	2	6	31										0				

Skove altid i zone 1 (N = 681) **Side 8 af 11** **Bilag G**

	Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede	
Enhed og skov	Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
SDJ Parcel i Søndermose			4	4										O				
SDJ Kragelund Mose			10	10				2					2	4	2	1		
SDJ Vejbæk Skov	36	39	12	87										O				
SDJ Bommerlund Planta	155	368	151	674		0	2	5		1		1	2	11	4	3		
SDJ Oksekær	1		2	3										O				
SDJ Skov ved Bjerndrup	1			1									1	1	1			
SDJ Bøghoved	13	4	2	20		25		1				1		2	1	1		
SDJ Areal syd for Sønder			3	3									1	1	1			
SDJ Hostrup Krat	16	12	4	31	3	3		3				1	1	5	2	2		5
SDJ Kæmpehøj i Hostrup				0										O				
SDJ Arealer på Varnæs H	1		79	80				1					1	2	2	1		
SDJ Årtoft Plantage	72	134	43	250				4		1		1	2	8	4	2		
SDJ Torp Plantage	87	84	38	209									1	1	1			
SDJ Hjordkær	5	1	1	7										O				
SDJ Årup Skov	195	36	55	285	1	0		3				1	1	5	3	2		
SDJ Sønderskov, Aabenr	86	7	11	104				1				1	1	3	2	1		
SDJ Hjælm	44	2	5	50	14			4				1	1	6	2	2		
SDJ Vestermark	96	10	14	120	2	3		1					1	2	2	1	13	
SDJ Langbjerg Skov	36	0	13	50		3		2						2	1	1		
SDJ Søst Skov	56	8	12	77		10		4						4	3	3		13
SDJ Nørreskov, Aabenra	76	9	13	97				2					1	3	3	2		
SDJ Rhedersborg Skov	25	9	4	37									1	1	1			
SDJ Rugbjerg Plantage	33	112	19	164								1	1	2				
SDJ Rundemølle	1		5	5	38	13								O				
SDJ Jagtprøvebane		1	8	9										O				
SDJ Strangelshøj			1	1										O				
SDJ Hjarup Mose			7	7									1	1	1			
SDJ Arealer ved Potterh			19	19									1	1	1			
SDJ Hop Sø			11	11				1				1	1	3	2	1		
SDJ Tormaj	7		4	11										O				
SDJ Fredshule	2		9	11										O				
SDJ Abkær Mose			37	37									1	1	1			
SDJ Femhøje			3	3										O				
SDJ Haderslev Sødersk	70	6	71	147	34			1				2		3	2	2		
SDJ Hjelmvrå	44	6	2	51				2				1		3	1	1		
SDJ Teglholt	20	2	17	40	12	3		1				1	2	4	2	1	46	
SDJ Tørning Mølle	21	1	68	90	8	1		2				2	2	6	3	2	17	
SDJ Sandkule	43	2	2	47	58	40		1				1	1	3	1	1	93	
SDJ Ladegård eng	0		10	11				1					1	2	1			
SDJ Elkær dambrug			5	5									1	1	1			
SDJ Vesterskov	151	17	20	187	12	2		6				1	3	10	5	3		
SDJ Nautrupgård Skov	9		0	9										O				
SDJ Tamdrup Høj			0	0										O				
SDJ Årø Skov mm	7		48	54				5					6	11	8	4		
SDJ Keldet Skov	9			9										O				
SDJ Loft Skov	15	2	1	18									1	1				
SDJ Revsø Skov	137	42	34	213	3	1		4				1	3	8	4	3	3	3
SDJ Gravhøj i Sommerst			0	0										O				
SDJ Areal ved Råde Stra			3	3										O				
STS Ovstrup Skov	159	22	40	221										O				
STS Sønder Kohave	60	1	8	70		14								O				
STS Gedser Fyr			4	4				3					5	8	6	3		
STS P-pladser på Falster			5	5										O				
STS Albuen			43	43				2					8	10	6	2		
STS Langødyssen og Bav			1	1										O				
STS Majbøllereservatet			34	34				1					8	9	4	1		
STS Enehøje	1	2	97	100								1	5	6	5			
STS Teglværksskoven	8		16	24				1				1	3	5	1			
STS Vildmarksskoven	7		2	9										O				
STS Krogsbølleskoven	15	0	5	20										O				
STS Krukholm Skov	24		14	37										O				
STS Hyllekrog Fyr			2	2									1	1	1			

Skove altid i zone 1 (N = 681) **Side 9 af 11** **Bilag G**

	Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede	
Enhed og skov	Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
STS Krukholm Lille Skov	4		2	6										0				
STS Øer på søterritoriet			15	15									1	1	1			
STS Mark ved Bursø			9	9										0				
STS Udby Skov	59	8	38	105				1						1				
STS Hegnede Skov	16	1	13	30				1					2	3	3	1		
STS Nyord			136	136				2					9	11	7	2		
STS Areal ved Hjelm Bug	1		1	2										0				
STS Bakkely Skov	37	8	18	63										0				
STS Tårnborggård			63	63				1					4	5	3	1		
STS Galgebakke og Hash			0	0										0				
STS Højbjerg Skov	35		76	112				1						1	1	1		
STS Kobæk Skov	30	1	68	99				1				1	6	8	6	2		
STS Glumsø Statsskov	8		36	44				1				1	3	5	2	1		
STS Areal ved Sandvig			9	9										0				
STS Prins Carls Skole				0										0				
STS Gåsetårnet				0										0				
STS Faksinge Skov	18		2	20										0				
STS Vrangstrup Enge v. S			51	51				2					2	4	2	2		
STS Anneliselunden			6	6										0				
STS Stevns Fyr			0	0										0				
STS Avnø	3		207	211				11				1	20	32	16	5		
STS Rønnebæk fælled	30	7	58	95				1				1		2	1	1		
STS Ladby Skov	17		18	35										0				
STS Fælleseje Skov	23	1	12	35										0				
STS Vridsløse Skov	20		35	55										0				
STS Even Skov	25	2	20	46										0				
STS Fakse Kalkbrud			15	15										0				
STS Fodsporet	20	0	63	83				1				1	1	3	2	1		
STS Øer på søterritoriet			9	9									2	2	2			
BON Arealer ved Arnager	4	1	3	8				2					1	3	3	2		
BON Areal ved Sose Odde			0	0										0				
BON Areal ved Nordbakk		2	1	2										0				
BON Areal ved Gubbegår		1	2	3										0				
BON Egeby fortidsminde			1	1										0				
BON Areal ved Hundsem			0	0										0				
BON Udkæret	3	0	24	27				6					5	11	5	3		
BON Kærgården	1	1	25	27				3					4	7	5	2		
BON Skovholt	1		4	5									2	2	1			
BON Ringborgen	0		10	10										0				
BON Arealer ved Vandmø	1		1	2										0				
BON Areal ved Stammers	1		1	2				1						1	1	1		
BON Byggehøj	2			2		100								0				
BON Rø Præsteskov	4			4										0				
BON Øster Borregårds Sk	24	7	10	40	4	27		2						2	1	1	83	
BON Areal ved Bobbeå	4	1	2	7		67								0				
BON Salene Bugt	5	1	3	8										0				
HST Trørød Hegn	51	1	4	55										0				
HST Kohave Skov	21	0	13	34						1		1	1	3	1			
HST Ermelunden	49	0	22	72				2	1			2	3	8	4	2		
HST Mikkelborg			7	7										0				
HST Bredelte	3			3										0				
HST Hørsholm Slotshave	5		15	19									1	1	1			
HST Bistrup Hegn	42	3	4	48	7			3				1	2	6	3	2		
HST Stumpedysse Hegn	10	4	1	15										0				
HST Sjælsø Lund	54	18	7	79		7		2				1	2	5	4	3		
VSJ Grønnehave Skov	45		5	49				3				1		4	3	3		
VSJ Annebjerg Skov	147	25	32	203	2	1		2				1	3	6	4	2		
VSJ Nakke Skov	38	4	26	68				6		1		2	9	18	13	6		
VSJ Højby Sø	3		56	59										0				
VSJ Skansehage			16	16				2					7	9	8	1		
VSJ Øer på søterritoriet			0	0										0				
VSJ Nygård Sø			33	33				1					3	4	3	1		

Skove altid i zone 1 (N = 681)

Side 10 af 11

Bilag G

	Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede	
Enhed og skov	Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
VSJ Ulkerup Skov	192	33	66	291		4		5				4		9	6	6		11
VSJ Stokkebjerg Skov	64	1	8	73				1						1	1	1		
VSJ Grevinge Skov	187	32	12	231				3		1				4	3	3		
VSJ Hønsehals Skov	35	19	40	94	4	5		2				1	3	6	5	3		
VSJ Bognæs Skov	28	10	13	51				1				1		2	1	1		
VSJ Mosemark Skov	26	22	5	53										O				
VSJ Øer på søterritoriet			1	1										O				
VSJ Ellinge Indhegning	21	97	8	126									1	1	1			
VSJ Jyderup Skov	70	131	12	213				3					2	5	4	2		
VSJ Bjergene			90	90				3					17	20	19	2		
VSJ Vollerup Skov	129	41	35	205				3					2	5	4	2		
VSJ Klosterskov	77	10	35	122				5		1			4	10	7	4		
VSJ Overby Lyng	1	2	12	15				2					6	8	6	1		
VSJ Stenstrup Troldstue			0	0										O				
VSJ Lærkereden			7	7										O				
VSJ Veddinge Bakker			5	5										O				
VSJ Sydspids af Sejerø			7	7				1						1	1	1		
VSJ Gravhøj ved Svebøll				0										O				
VSJ Vestborgen			2	2										O				
VSJ Stenhus i Kalundbor			0	0										O				
VSJ Øer på søterritoriet			0	0										O				
VSJ Vrangeskov	32	19	3	54									1	1	1			
VSJ Fællesfolden			96	96				2				4	10	16	9	3		
VSJ Svallerup Strand			1	1										O				
VSJ Langesø Eng			4	4										O				
VSJ Langdysse ved Viels			0	0										O				
VSJ Knud Lavards Kapel			0	0										O				
VSJ Tadre Mølle			13	13										O				
VSJ Øer på søterritoriet			2	2										O				
VSJ Fugledegaard			72	72									1	1	1			
VSJ Pedersted Skov	26	2	1	29										O				
VSJ Stubberup Skov	5			5										O				
VSJ Kattinge Søerne			86	86				2		1			4	7	4	1		
VSJ Gershøj			2	2										O				
VSJ Arealer ved Ejby			4	4										O				
VSJ Arealer ved Gamme			58	58				2						2	2	2		
VSJ Høng Skov	39	4	10	54				1					1	2	2	1		
VSJ Benløse Skov	28	2	22	53				1					2	3	2	1		
VSJ Skovrejsning Slagels			34	34										O				
NSJ Brødemose skov	47	9	15	70				1				2		3	1	1		
NSJ Avderød skov	57	6	8	70		1		4					3	7	6	4		
NSJ Holstrupgård	1		43	44										O				
NSJ Fuglsanggård	1		63	64									6	6	4			
NSJ Kanalerne	2		6	8										O				
NSJ Nordhuse	2		10	11				2						2	2	2		
NSJ Arrenæs-arealer	10	6	158	175				5					3	8	7	5		
NSJ Statens tørvemose	7		0	7		61								O				
NSJ Hyttegården			6	6										O				
NSJ Hovgårds pynt			4	4										O				
NSJ Holløse bredning			86	86				5				2	10	17	7	3		
NSJ Alsønderup enge			57	57				4				2	5	11	4	2		
NSJ Solbjerg enge			57	57				6				2	8	16	4	2		
NSJ Lyngby mose			55	55										O				
NSJ Ullerup skov	71	10	20	101				9		2		5	5	21	12	8		
NSJ Sandflugtsplantager	2	10	1	13										O				
NSJ Hyllingbjerg	0		3	3									2	2	2			
NSJ Stejlepladserne			6	6									2	2	2			
NSJ Skansen			0	0						1				1				
NSJ Sandflugtsmonumer			1	1										O				
NSJ Helenekilde			0	0										O				
NSJ Strandbjerggård	1	5	13	19									1	1	1			
NSJ Vieholmgård			14	14										O				

Skove altid i zone 1 (N = 681)

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Bilag G

	Areal (ha)				skov allered		Antal arter fra hver zone gruppe								Prioritet A arte		%obs allerede	
Enhed og skov	Løv	Nål	Lysåbe	Total	i z3	i z4	z2	z3	z4	z23	z24	z34	ikke-skov	Total	Alle	Skov	i z3	i z4
NSJ Rågegården	8	1	5	13									2	2	2			
NSJ Gilbjerggård	1	2	37	40			1	9		2		4	20	36	23	8		
NSJ Valby Hegn	267	63	30	360	0	5		6			1	6	3	16	11	8		6
NSJ Høbjerg hegn	137	9	6	151				2				2	2	6	4	2		
NSJ Nejede vesterskov	88	12	7	107	49	48		4		1		4	4	13	5	3	99	1
NSJ Æbelholt klosterruir			1	1										O				
NSJ Skævinge	53	23	143	219				1					1	2	2	1		
NSJ Gørløse	24	4	101	129										O				
NSJ Søborg Slotsruin			11	11										O				
NSJ Klosterhus			0	0										O				
NSJ Esrum Kanal			5	5										O				
NSJ Parcel i Nødebo			0	0										O				
NSJ Sørup Havn			1	1										O				
NSJ Fredensborg Havn			2	2										O				
NSJ Nødebo Holt	45	3	2	49	96	4						6	2	8	1	1	100	
NSJ Gadevang Skov	97	50	14	160				2		2		6	4	14	4	3		
NSJ Selskov	44	2	1	47				1				1		2	1	1		
NSJ Mose i Gadevang	1		0	1								1	1	2				
NSJ Tirsdagsskoven	13		1	14										O				
NSJ Brøde Skov	143	23	14	179	1	0		2				1	4	7	3	1		
NSJ Lille Hestehave	13		24	37	23	76		1				2		3	3	3	33	33
NSJ Snevret	50	8	10	67	19	24		1					3	4	1	1		
NSJ Horneby Sand	9	10	51	70									1	1	1			
NSJ Risby Vang	59	5	3	66						1			1	2				
NSJ Krogenberg Hegn	154	72	25	251	4			5		2	1	2	1	11	6	6	9	
NSJ Munkegårds Hegn	21		0	22									1	1				
NSJ Endrup Hegn	27	6	1	34				1						1				
NSJ Kelleris Hegn	54	8	3	65	2			1					1	2	2	1		
NSJ Dageløkke Skov	24	2	34	59										O				
NSJ Skipperholm	7		3	10	59	19								O				
NSJ Kovang	5			5										O				
NSJ Knorrenborg Vang	67	12	30	109				3		1		1	2	7	3	2		
NSJ Grønholt Vang	164	27	45	236	8	12		6		1		8	1	16	7	6	2	8
NSJ Grønholt Hegn	183	42	48	273		2		1			1	4	1	7	2	2		
NSJ Stasevang	51	14	8	72		1		1			1	2	1	5	2	2		
OSJ Farum Sø			125	125				3				1	6	10	5	2		
OSJ Nyvang	35	14	11	59	16			5				2	5	12	11	6	60	
OSJ Skydebanearealerne	2		11	13										O				
OSJ Ganløse Forte			1	1										O				
OSJ Brudehøje			0	0				1						1	1	1		
OSJ Kollekolle	19	1	84	104	5			1				1	1	3			33	
OSJ Snubbekorsskoven			13	13				1						1	1	1		
OSJ Karlstrup Skov	43	12	154	208	1			5				2	8	15	10	4		
OSJ Øer i Køge Bugt			63	63				1		1			26	28	17	1		
OSJ Regnemark			11	11				1					2	3	3	1		
OSJ Ramsø			12	12				2					5	7	2	1		
OSJ Greve Skov	60	13	38	111										O				
OSJ Solhøj Fælled	3	7	104	113				1						1	1	1		
OSJ Tune Skov	30	3	54	87				1						1	1	1		
OSJ Kildebrønde Skov			10	10										O				
OSJ Sønderskov	25	9	10	44	17			3				5	4	12	5	3		
OSJ Lystrup Skov	138	18	43	199	2			1				2	1	4	4	3		
OSJ Uggeløse skov	124	17	20	162	3	5		5				3	6	14	10	4		
OSJ Krogenlund	51	2	23	76		17		6	1			4	8	19	15	7		11
OSJ Bastrup sø			42	42				2					8	10	8	2		
OSJ Hammergård m.m.	5	0	11	16										O				
OSJ Sperrestrup skov	79	6	31	116										O				
OSJ Grønlien skov	37	6	10	52				3						3	3	3		
OSJ Hørup Skov	7		45	51				1						1	1	1		
OSJ Gulddysse Skov	72	8	40	121				5						5	4	4		
OSJ Himmelev Skov	37	19	84	140				4					4	8	6	3		

Bilag H

Bilag H. Resultater fra alle scenarier.

Scenarie	z1 % areal	z2 % areal	z3 % areal	z4 % areal	Tab % årligt	z4 (ha)	z4 (n)	GM	Mål nået (af 304 arter)
A penge	25,9	24,3	28,2	21,7	61,3	22.933	78	0,83	217
B areal	26,9	23,6	29,2	20,3	61,4	21.541	75	0,84	215
C penge	39,3	0	38,2	22,5	68,7	23.797	85	0,87	199
D areal	39,3	0	38,2	22,5	68,7	23.807	88	0,87	199
E penge	37,1	20,3	25,1	17,5	53,0	18.502	59	0,86	229
F areal	38,3	19,7	25,6	16,5	53,6	17.424	60	0,87	232
G penge	**57,8**	**13,7**	**15,2**	**13,3**	**36,9**	**14.094**	**43**	**0,91**	**257**
H areal	**58,2**	**13,4**	**15,6**	**12,8**	**37,1**	**13.519**	**45**	**0,91**	**257**
I penge	25,9	24,3	29,5	20,4	53,9	21.573	70	0,83	217
J areal	26,9	23,6	30,3	19,2	53,5	20.302	70	0,84	215
K penge	39,3	0	40,3	20,4	58,4	21.577	73	0,87	199
L areal	39,3	0	40,6	20,1	58,4	21.241	73	0,87	199
M penge	37,1	20,3	27,7	14,9	45,6	15.803	44	0,86	229
N areal	38,3	19,7	28,1	14,0	45,9	14.810	44	0,87	232
O penge	**57,9**	**13,1**	**18,8**	**10,2**	**32,6**	**10.763**	**40**	**0,92**	**261**
P areal	**58,2**	**13,0**	**19,5**	**9,4**	**32,4**	**9.964**	**35**	**0,92**	**262**
Q penge	36,7	20,3	28,6	14,4	46,1	15.281	50	0,87	231
R areal	38,1	19,7	27,3	15,0	46,5	15.878	49	0,88	230
S penge	26,0	24,2	29,3	20,5	50,3	21.693	74	0,85	221
T penge	**35,8**	**24,3**	**23,5**	**16,4**	**42,7**	**17.338**	**61**	**0,90**	**255**
U penge	36,7	20,3	28,6	14,4	45,5	15.281	50	0,87	231
V penge	**58,0**	**13,0**	**19,1**	**9,9**	**30,5**	**10.524**	**39**	**0,91**	**258**
W penge	26,0	24,2	29,3	20,5	42,9	21.693	74	0,85	221
X penge	**35,8**	**24,3**	**23,5**	**16,4**	**36,3**	**17.338**	**61**	**0,90**	**255**
Y penge	36,7	20,3	28,6	14,4	38,1	15.281	50	0,87	231
Z penge	**58,0**	**13,0**	**19,1**	**9,9**	**25,5**	**10.524**	**39**	**0,91**	**258**
Q1	57,2	15,5	15,2	12,1	33,1	12.771	33	0,93	166
Q2	46,5	9,4	19,4	24,7	48,1	26.119	69	NA	NA
Q3	46,5	0	0	53,5	58,9	56.679	203	NA	NA

Linjer i fed *er scenarier med målet sat til 3 repræsentationer i stedet for 5. GM = gennemsnitlig målopfyldelse for de prioritet A arter, som indgår i scenariet. z = zone. NA = ikke relevant. Alle areal mål gælder skovbevokset areal, dvs. uden lysåbne områder som græsland, søer, veje m.v.. Se tabel 3 og 13 for hver scenaries forudsætninger.*

Gap arter i scenarie Q (N = 73)

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Bilag I

Artsgruppe	Arts navn	Truet hvor?	Rødliste	Tilbagegå	Prioritet	Præference	Saproxyl?	Gruppe	Zone	Skove (N)	Match	gap?
Pattedyr	Bredøret flagermus	EU anx 2 art	VU	nej	A	Løv	Ej-saproxyl	Åben skov	3	4	3	gap1
Biller	Allecula morio	DK	VU	ja	A	Løv	Saproxyl	Åben saproxyl	3	1	0	gap1
Biller	Ampedus hjorti	Globalt	VU	nej	A	Løv	Saproxyl	Åben saproxyl	3	5	3	gap2
Biller	Eghjort	DK	RE	RE	A	Løv	Saproxyl	Åben saproxyl	3	2	0	gap2
Biller	Grøn pragttorbist	DK	CR	ja	A	Løv	Saproxyl	Åben saproxyl	3	1	0	gap1
Biller	Matsort træsmælder	DK	VU	ja	A	Løv	Saproxyl	Åben saproxyl	3	5	3	gap2
Biller	Pragtsmælder	DK	VU	ja	A	Løv	Saproxyl	Åben saproxyl	3	1	0	gap1
Biller	Sort blomsterbuk	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	12	4	gap1
Biller	Tachyta nana	DK	VU	ja	A	Løv	Saproxyl	Åben saproxyl	3	1	0	gap1
Tovinger	Hvidbåndet rovflue	DK	CR	ja	A	Løv	Ej-saproxyl	Åben skov	3	2	1	gap1
Tovinger	Lille træsvirreflue	DK	VU	ja	A	Løv	Saproxyl	saproxyl skovart	4	3	2	gap1
Tovinger	Mørk myresvirreflue	DK	VU	ja	A	Løv	Saproxyl	Åben saproxyl	34	6	4	gap1
Tovinger	Pragtsvirreflue	DK	EN	ja	A	Løv	Saproxyl	saproxyl skovart	4	2	1	gap1
Tovinger	Smuk løgsvirreflue	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	2	1	gap1
Tovinger	Sort træsmuldsvirreflue	DK	EN	ja	A	Løv	Saproxyl	saproxyl skovart	4	4	2	gap2
Tovinger	Sort vedrovflue	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	4	1	gap3
Tovinger	Stikkelsbær-glanssvirreflue	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	4	2	gap2
Tovinger	Sump-urtesvirreflue	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	1	0	gap1
Tovinger	Tidlig ornamentsvirreflue	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	5	3	gap2
Tovinger	Uldhåret pelssvirreflue	DK	VU	ja	A	Løv	Saproxyl	saproxyl skovart	4	5	4	gap1
Årevinger	Blank gæstemyre	Globalt	VU	nej	A	Nål obligat	Ej-saproxyl	Nål obligat	2	5	3	gap2
Dagsommerfug	Kirsebærtakvinge	DK	CR	ja	A	Løv	Ej-saproxyl	Åben skov	3	5	3	gap2
Dagsommerfug	Rødlig perlemorsommerfugl	DK	CR	ja	A	Løv	Ej-saproxyl	Åben skov	3	7	4	gap1
Sommerfugle	Brachionycha nubeculosa	DK	RE	RE	A	Løv	Ej-saproxyl	Åben skov	3	1	0	gap1
Sommerfugle	Dværgspinder	DK	CR	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	4	3	gap1
Sommerfugle	Gran-nonne	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	3	0	gap3
Sommerfugle	Rødbrun ordenugle	DK	RE	RE	A	Løv	Ej-saproxyl	Åben skov	3	4	3	gap1
Sommerfugle	Stribet målerugle	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	4	3	gap1
Sommerfugle	Trapez-glansugle	DK	RE	RE	A	Løv	Ej-saproxyl	Åben skov	3	1	0	gap1
Græshopper	Stor enggræshoppe	DK	CR	ja	A	Løv	Ej-saproxyl	Åben skov	3	4	1	gap3
Edderkopper	Midia midas	DK	EN	ja	A	Løv	Ej-saproxyl	Åben skov	3	1	0	gap1
Edderkopper	Orange hjulspinder	DK	EN	ja	A	Løv	Ej-saproxyl	Åben skov	3	2	1	gap1
Sæksvampe	Kæmpe-stenmorkel	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	3	1	gap2
Basidiesvamp	Ædelgran-mælkehat	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	7	2	gap3
Basidiesvamp	Blåfodet kødpigsvamp	DK	CR	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	4	3	gap1
Basidiesvamp	Brandgul fagerhat	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	2	1	gap1
Basidiesvamp	Brungul rødblad	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	5	4	gap1
Basidiesvamp	Brusk-bævretop	DK	VU	ja	A	Løv	Saproxyl	saproxyl skovart	4	4	3	gap1
Basidiesvamp	Cinnober-muslingesvamp	DK	EN	ja	A	Løv	Saproxyl	saproxyl skovart	4	1	0	gap1
Basidiesvamp	Duftende kæmpeskælhat	DK	VU	ja	A	Løv	Saproxyl	saproxyl skovart	4	5	4	gap1
Basidiesvamp	Entoloma lampropus	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	3	2	gap1
Basidiesvamp	Glat ildporesvamp	DK	EN	ja	A	Løv	Saproxyl	saproxyl skovart	4	2	1	gap1
Basidiesvamp	Gylden grynskælhat	DK	EN	ja	A	Løv	Saproxyl	saproxyl skovart	4	4	3	gap1
Basidiesvamp	Højstokket ridderhat	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	3	1	gap2
Basidiesvamp	Hypholoma ericaeum	DK	EN	ja	A	Løv	Ej-saproxyl	Åben skov	3	1	0	gap1
Basidiesvamp	Inocybe sambucina	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	2	1	gap1
Basidiesvamp	Lak-skørhat	DK	VU	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	4	3	gap1
Basidiesvamp	Maj-rødblad	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	4	2	gap2
Basidiesvamp	Mønster-lædersvamp	DK	CR	ja	A	Løv	Saproxyl	saproxyl skovart	4	2	1	gap1
Basidiesvamp	Orangegul ridderhat	DK	EN	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	6	3	gap2
Basidiesvamp	Punktstokket vokshat	DK	EN	ja	A	Løv	Ej-saproxyl	Åben skov	3	1	0	gap1
Basidiesvamp	Rosalilla rødblad	DK	EN	ja	A	Løv	Ej-saproxyl	Urørt løvskov	4	2	0	gap2
Basidiesvamp	Sortfodet stilkporesvamp	DK	VU	ja	A	Løv	Saproxyl	saproxyl skovart	4	5	4	gap1
Basidiesvamp	Strågul køllesvamp	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	6	4	gap1
Basidiesvamp	Teglfarvet mælkehat	DK	EN	ja	A	Nål obligat	Ej-saproxyl	Nål obligat	2	2	1	gap1
Basidiesvamp	Tofarvet foldporesvamp	DK	EN	ja	A	Løv	Saproxyl	saproxyl skovart	4	5	2	gap3
Basidiesvamp	Tomentella lateritia	DK	VU	ja	A	Løv	Saproxyl	saproxyl skovart	4	3	1	gap2
Basidiesvamp	Vellugtende læderporesvamp	DK	EN	ja	A	Løv	Saproxyl	saproxyl skovart	4	2	1	gap1
Basidiesvamp	Violet koralsvamp	DK	EN	ja	A	Løv	Ej-saproxyl	Anden løvskov	34	2	1	gap1
Lav	Brungrøn bægerlav	DK	VU	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	3	2	gap1
Lav	Elegant skållav	DK	EN	ja	A	Løv	Ej-saproxyl	Åben skov	3	2	0	gap2
Lav	Opblæst bægerlav	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	5	4	gap1
Lav	Sprække-punktlav	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	4	3	gap1
Lav	Tørve-bægerlav	DK	CR	ja	A	Nål fakultativ	Ej-saproxyl	Nål fakultativ	23	1	0	gap1
Lav	Ved-nålesvamp	DK	CR	ja	A	Løv	Ej-saproxyl	Åben skov	3	1	0	gap1
Karplanter	Blåtoppet kohvede	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	2	1	gap1
Karplanter	Eng-hejre	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	3	2	gap1
Karplanter	Finsk røn	DK	CR	ja	A	Løv	Ej-saproxyl	Åben skov	3	5	4	gap1
Karplanter	Fruesko	EU anx 2 art	VU	nej	A	Løv	Ej-saproxyl	Åben skov	3	2	1	gap1
Karplanter	Hvidplettet lungeurt	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	4	2	gap2
Karplanter	Kantet kohvede	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	4	3	gap1
Karplanter	Kost-nellike	DK	VU	ja	A	Løv	Ej-saproxyl	Åben skov	3	4	3	gap1
Karplanter	Tørve-viol	DK	CR	ja	A	Løv	Ej-saproxyl	Åben skov	3	2	0	gap2

Se nederst på Bilag B for forklaring på overskrifter.

Resultat af manuel optimering ved zoneopdeling af skove (N = 48). Bilag J

Enhed og skov		Areal i hektar løv	nål	åbent	i alt	Ha z3 allerede	Ha z4 allerede	Zone Mx_Q	Zone for gap-art	Zoner manuel	Kommentar om især zone 4
HIM	Nørreskov	181	227	64	472	93	46	4	23	430	Kun z4 i NV og ikke hidtidig græsningsskov
HIM	Skindbjerglund	37	1	12	50	41	6	3	4	43	z3 ok. Urørt-arterne har allerede urørt.
HIM	Fællesskov	187	307	98	592	191	49	3	2	32	Nat.strat. uændret er fint for arterne
VJY	Hoverdal Plantage	115	1039	408	1562	0	0	3	2	32	
VJY	Fejsø Plantage	200	658	731	1588	0	42	2	3	32	
SHL	Nordskov	191	607	188	986	171	110	2	34	42	z24 kombi (evt delvis)
SHL	Odderholm	2	1	24	27	0	0	4	23	432	Split aht to gap arter. Z4 kun for skovdel.
SHL	Lysbro Skov	39	43	67	149	10	21	4	3	430	Nat.strat. uændret er fint for arterne
SHL	Vesterskov	184	375	94	653	187	175	4	23	4320	Nat.strat. uændret er fint for arterne
VSY	Læsø Plantage	375	786	714	1875	162	40	3	4	4320	z24 behøves delvis, lysninger holdes åbne
THY	Vilsbøl Plantage	143	473	603	1218	0	0	3	2	32	
THY	Hanstholm Kystskrænt	2	5	245	252	0	0	3	4	3	z3 OK. Gap-Rødbladen vokser også i ore.
THY	Svinkløv Plantage	132	332	253	717	0	0	3	24	432	Split z24 undt. z3 i NV
KJY	Indskovene	276	88	461	825	106	78	2	3	32	Nat.strat. uændret er fint for arterne
KJY	Markerne	2	0	388	390	0	0	3	2	32	
MJY	Palsgård Skov	149	720	235	1104	0	0	3	2	32	
VAD	Draved Skov og Kongens	198	1	366	565	6	259	4	3	43	Nat.strat. uændret er fint for arterne
FYN	Kasmose Skov	11	0	9	20	9	5	4	3	43	Nat.strat. uændret er fint for arterne
FYN	Sydlangeland	106	7	333	447	42	1	3	4	3	z3 OK. Gap-arten havde fejl i præf.
TRE	Stagsrode Skov	176	30	12	218	10	19	4	23	432	OK z4 inkl urørt nål. Kan evt reduceres
TRE	Svanemosen	34	2	88	124	26	34	3	4	43	Nat.strat. uændret er fint for arterne
STS	Klinteskov	250	2	286	538	208	128	4	3	430	Fasthold græsn.skov. Udelad randskove.
STS	Ulvshale Skov	90	13	308	410	19	94	4	3	43	ok z4 for skovdele, men allerede urørt
STS	Kongskilde	37	2	285	324	0	0	4	3	3	z3 i stedet for z4 efter rettet økol behov
BON	Almindingen	916	1097	406	2420	82	71	3	24	4320	Delvis z4 (inkl nål) + z3 strøg
BON	Ølene	13	6	76	95	16	22	3	2	32	Allerede urørt mht skov. Bevar nål delvis.
BON	Hammerknuden	23	5	170	197	100	0	2	3	320	Bevar noget nål i området
BON	Rø Plantage	213	320	60	593	0	0	3	2	320	Bevar noget nål i området
HST	Jægersborg Hegn	426	32	96	554	83	6	4	3	430	Delvis z4 og 3 + græsning. z2 art var fejl.
HST	Geel Skov	145	39	9	193	0	0	4	23	432	Evt z4 hele skoven + nål essentiel.
HST	Jægersborg Dyrehave	435	8	452	895	776	28	4	3	43	z3 OK efter rettede øko behov +lidt urørt.
HST	Ordrup Krat	17	0	38	55	0	0	4	3	4	z4 ok eft rettet øko behov, split ej.
HST	Kongelunden	208	49	74	331	0	0	3	2	32	OK t z23 nærmest normal drift
HST	Vestamager	236	0	1730	1966	132	46	3	4	430	Split evt. al skov t z4. Rest lysåbent.
HST	Rude Skov og Friheden	321	120	130	571	107	45	2	34	4320	z24 inkl nål, ekskl lysåbne.
VSJ	Røsnæs	22	8	166	196	0	0	2	3	320	Nål og lysåbent fokus.
VSJ	Bidstrup Skovene	646	195	181	1021	21	17	3	4	430	Split t ca 100 ha z4 + z3 bryn fokus
VSJ	Boserup Skov	168	26	29	224	29	14	4	3	43	Split i z3 + z4, fx 50/50
NSJ	Tisvilde hegn	338	1280	375	1992	8	128	2	34	432	z4 Hegnet, z2 plantagerne, z3 melby ore
NSJ	Gribskov	1943	1180	722	3845	411	303	4	23	432	z24 urørt inkl. urørt nål, multizone behov
NSJ	Søskoven	498	188	100	785	288	44	4	3	30	Dele z3 ok eft rettet øko behov. Ej z4 behov.
NSJ	Hornbæk Plantage	105	71	22	198	0	0	3	2	32	z 23 fyrreskovs fokus
OSJ	Ryget	115	21	14	149	25	45	4	3	4	ok t z4 eft rettet øko behov for tørveviol
OSJ	Nørreskoven	169	11	13	194	24	18	4	3	4	ok z4 efter rettet øko behov. Kan reduceres
OSJ	Ganløse Ore	216	150	30	396	0	5	4	2	42	OK t z4. Nål vigtig. Kan reduceres
OSJ	Store Hareskov	181	69	45	295	14	0	4	3	43	OK t z4 hele skoven. Kan reduceres.
OSJ	Vestskoven	556	183	604	1342	0	0	4	23	32	Normal drift, ej z4 eft rettet øko behov.
OSJ	Ravnsholt	150	123	40	312	3	1	4	3	32	z3 inkl nål dødtved efter rettet øko behov.

Zoneforskel mellem scen. Q, Q1 og Q2 (N = 146)

Side 1 af 2 **Bilag K**

		Areal (ha)				Zone valgt i scenarie		
Enhed og skov		Løv	Nål	Lysåben	Total	Q	Q1	Q2
HIM	Nørreskov	181	227	64	472	4	3	4
HIM	Skindbjerglund	37	1	12	50	3	3	4
HIM	Navn Sø			100	100	3	1	3
HIM	Fællesskov	187	307	98	592	3	3	4
VJY	Klosterheden Plantage	847	4462	1090	6399	3	1	3
VJY	Arealer ved Ferring og Trans Kirke			73	73	3	1	3
VJY	Harboøre Tange			1114	1114	3	1	3
VJY	Hoverdal Plantage	115	1039	408	1562	3	3	4
VJY	Fejsø Plantage	200	658	731	1588	2	2	4
VJY	Husby Plantage	100	710	256	1066	2	1	2
VJY	Arealer i Ringkøbing kommune			7	7	3	1	3
VJY	Fjand Enge		4	253	257	3	1	3
VJY	Vest Stadil Fjord			1108	1108	3	1	3
VJY	Sandfær	20	21	529	569	3	1	1
VJY	Tihøje Hede	6		210	217	3	1	3
SHL	Østerskoven, østlige del	92	138	149	379	3	1	3
SHL	Nordskov	191	607	188	986	2	2	4
SHL	Bjørnholt	11	25	31	66	3	1	1
SHL	Trustrup Høje	0	2	6	8	3	1	3
SHL	Høgdal	18	12	24	53	3	1	3
SHL	Kallehave	3	21	16	39	3	3	1
SHL	Klostermølle mm.	6	7	47	60	4	1	4
SHL	Ny Vissingkloster	24	26	39	89	3	3	1
SHL	Kobskov Vest	19	4	55	77	3	1	3
VSY	Læsø Plantage	375	786	714	1875	3	2	4
VSY	Skagen Plantage	44	698	732	1474	3	3	4
VSY	Bunken Plantage	47	484	690	1221	2	2	1
VSY	Ålbæk Plantage	79	525	132	736	1	2	1
VSY	Uggerby Plantage	83	427	276	786	2	1	2
VSY	Tornby Plantage	42	280	237	560	2	1	2
VSY	Tranum Plantage	272	1408	2243	3922	4	1	3
VSY	Hune Plantage	5	54	6	65	2	1	2
VSY	Grishøjgårds Krat	4		161	165	1	3	1
THY	Lyngby Hede		73	1196	1270	2	1	2
THY	Ejerslev Vang			12	12	1	3	1
THY	Nystrup Plantage, østlige del	94	833	311	1239	2	1	2
THY	Nystrup Plantage, vestlige del	17	234	612	863	1	2	2
THY	Vilsbøl Plantage	143	473	603	1218	3	2	4
THY	Hanstholm Vildtreservat		80	3208	3288	2	2	1
THY	Hanstholm Kystskrænt	2	5	245	252	3	1	4
THY	Hjardemål Plantage	61	707	388	1156	1	2	1
THY	Madsbøl Plantage	12	325	436	773	3	1	3
THY	Lild Plantage, vestlige del	71	631	584	1287	2	1	1
THY	Vester Thorup Plantage	117	1059	328	1504	2	2	1
THY	Svinkløv Plantage	132	332	253	717	3	2	4
THY	Langdal Plantage	32	122	22	176	3	1	3
KJY	Indskovene	276	88	461	825	2	3	2
KJY	Ajstrup Strand	13		10	22	4	1	4
KJY	Mols Bjerge	60	60	715	836	3	3	4
KJY	Helgenæs Syd	6	29	174	209	3	1	3
KJY	Dragsmur	1	2	51	53	3	1	1
KJY	Ørnbjerg Mølle	9	35	53	97	4	1	4
KJY	Gjerrild Strand	8	2	38	48	2	1	2
KJY	Viborg Plantage	132	275	29	437	2	1	2
KJY	Stanghede	37	15	198	249	3	1	3
KJY	Inderø Skov	70	3	5	78	3	1	3
KJY	Kalø Hovedgård		1	7	7	3	1	3
KJY	Markerne	2	0	388	390	3	3	4
MJY	Rydhave Skov	29	1	1	31	3	1	3
MJY	Mønsted Kalkgruber	2		15	17	4	3	3
MJY	Kompedal Plantage	243	2062	378	2683	2	1	1
MJY	Nørlund Plantage	112	1435	1435	2982	3	2	3
MJY	Bøllingsø	29	26	575	630	2	1	2
MJY	Palsgård Skov	149	720	235	1104	3	2	4
MJY	Gludsted	181	2597	689	3467	2	1	1
VAD	Hønning Plantage	120	256	148	524	2	2	1
VAD	Soldaterskoven	66	31	76	173	3	1	1
VAD	Klaskeroj Skov	73	27	18	118	3	1	1
VAD	Stursbøl Hegn	145	244	76	465	3	1	1
VAD	Kirkeby Plantage	6	166	235	406	3	1	1
VAD	Rømø Strand		2	4171	4173	3	1	3
VAD	Tingdal Plantage	11	9	9	29	3	1	3
FYN	Topgården	2		25	27	3	1	3
FYN	Frøbjerg Bavnehøj	1		10	11	3	1	1
FYN	Thurø Rev			36	36	3	1	3

Zoneforskel mellem scen. Q, Q1 og Q2 (N = 146)

Enhed og skov		Areal (ha) Løv	Nål	Lysåben	Total	Zone valgt i scenarie Q	Q1	Q2
FYN	Lille Rise	2	6	2	9	3	1	3
FYN	Ristinge	12	6	54	72	3	1	1
FYN	Sydlangeland	106	7	333	447	3	3	4
BLH	Kærgård Plantage, nordlige del	71	398	285	754	4	1	4
BLH	Vejers Plantage, sydlige del	19	387	284	691	2	1	2
BLH	Ål Plantage	95	377	127	599	3	1	3
BLH	Skallingen			2003	2003	3	1	3
BLH	Fanø Plantage	54	620	580	1254	3	1	3
TRE	Frederikshåb Plantage	80	504	220	804	3	1	1
TRE	Gyttegård Plantage	34	205	252	491	4	1	4
TRE	Skærsø	7	1	5	12	3	1	3
TRE	Randbøl Hede	0	2	710	712	3	1	3
TRE	Skovhave M.M.	2		15	17	3	3	1
TRE	Kærskov	69	14	6	89	2	2	1
TRE	Tapsøre Statsskov	148	15	69	232	3	1	3
TRE	Svanemosen	34	2	88	124	3	4	4
SDJ	Dybbøl	0		198	198	4	1	4
SDJ	Hønsnap Skov	62	11	10	84	3	1	1
SDJ	Frøslev Mose	7	0	327	335	3	1	3
SDJ	Areal ved Assenholm			18	18	3	1	3
SDJ	Østerskov	145	25	15	185	3	3	1
STS	Klinteskov	250	2	286	538	4	3	4
STS	Dybsø			136	136	2	1	1
BON	Blykobbe Plantage	86	86	32	204	2	1	2
BON	Almindingen	916	1097	406	2420	3	4	4
BON	Ejendommen Lassen	1	6	6	12	3	1	1
BON	Ølene	13	6	76	95	3	2	4
BON	Hammerknuden	23	5	170	197	2	1	3
BON	Hammersholm og Hammershus	38		169	207	3	1	3
BON	Slotslyngen	83	12	67	162	3	1	3
BON	Del af Ringebakkerne			22	22	2	1	2
BON	Borrelyngen	6	1	32	38	3	1	3
BON	Rø Plantage	213	320	60	593	3	3	4
HST	Enrum Skov	18	1	12	30	3	2	3
HST	Charlottenlund Skov	51		24	75	3	1	3
HST	Vestamager	236		1730	1966	3	4	4
HST	Kalvebod Fælled	28	0	153	182	3	1	3
HST	Rude Skov og Friheden	321	120	130	571	2	3	2
VSJ	Korshage	10	7	60	76	2	1	2
VSJ	Sonnerup Skov	66	173	49	287	3	2	3
VSJ	Kårup Skov	51	93	26	170	2	2	1
VSJ	Røsnæs	22	8	166	196	2	2	4
VSJ	Diesbjerg			3	3	3	3	1
VSJ	Bidstrup Skovene	646	195	181	1021	3	3	4
VSJ	Boserup Skov	168	26	29	224	4	3	4
NSJ	Arresødal skov	63	7	15	85	4	1	4
NSJ	Sonnerup Skov	45	12	3	60	3	1	3
NSJ	Lyngby skov	51	7	9	66	3	1	3
NSJ	Ll. lyngby mose	2	2	46	50	3	1	3
NSJ	Tisvilde hegn	338	1280	375	1992	2	4	4
NSJ	Gilbjerggård	1	2	37	40	1	3	1
NSJ	Stenholt Vang	198	81	35	313	2	1	1
NSJ	Søskoven	498	188	100	785	4	3	4
NSJ	Esrum Sø			1734	1734	3	3	1
NSJ	Nakkehoved	5		23	28	3	1	3
NSJ	Hornbæk Plantage	105	71	22	198	3	1	4
NSJ	Teglstrup Hegn	306	138	100	544	4	3	4
NSJ	Egebæksvang Skov	93	1	25	119	3	1	3
NSJ	Horserød Hegn	381	166	70	616	4	1	4
NSJ	Gurre Vang	146	38	258	442	4	1	4
NSJ	Fredensborg Skovene	10	2	0	12	3	1	3
OSJ	Ryget	115	21	14	149	4	1	4
OSJ	Nørreskoven	169	11	13	194	4	3	4
OSJ	Furesø			932	932	3	1	3
OSJ	Terkelskov	38	3	14	54	3	1	3
OSJ	Ganløse Ore	216	150	30	396	4	2	4
OSJ	Jonstrup Vang	174	27	38	240	4	4	1
OSJ	Ravnsholt	150	123	40	312	4	2	4
OSJ	Krogenlund	51	2	23	76	1	3	1
OSJ	Slagslunde skov	188	17	19	224	4	1	1
OSJ	Ganløse Eged m.m.	129	22	16	167	3	1	3

Gap-arter i scen. Q eller Q1 (N = 155). **Side 1 af 2** **Bilag L**

Sorteret efter truet hvor og Gap.

Artsgruppe	Artsnavn	Truet hvor	Zone	Gap_Q	Gap_Q1	Økologiske behov	Videnskabeligt navn
Årevinger	Blank gæstemyre	Globalt	2	gap2	gap5	Myretuer af rød skovmyre	Formicoxenus nitidulus
Biller	Ampedus hjorti	Globalt	3	gap2	gap3	Gl træer med dødt ved, især eg	Ampedus hjorti
Karplanter	Cypres-ulvefod	EU	3		gap4	Råjord i m. lys skov / hede; brand.	Diphasiastrum tristachyum
Padder	Løvfrø	EU	3		gap1	Rent klart ynglevand fri for fisk	Hyla arborea
Snegle	Skæv vindelsnegl	EU	34		gap1	Lysninger i skov, kalkrig jordbund	Vertigo angustior
Karplanter	Flad ulvefod	EU	3		gap1	Råjord i m. lys skov / hede; brand.	Diphasiastrum complanatum
Pattedyr	Bredøret flagermus	EU	3	gap1		Insektrig skov-lysåben mix, huler	Barbastella barbastellus
Karplanter	Fruesko	EU	3	gap1		Kalkrig / lerbund	Cypripedium calceolus
Lav-Sæksvamp	Opblæst bægerlav	DK	3	gap1	gap5	Ren fugtig luft.	Cladonia sulphurina
Sommerfugle	Treforkugle	DK	3		gap5	Lysåbent, næringsfattigt.	Acronicta tridens
Årevinger	Enghumle	DK	3		gap5	Lysåbent, næringsfattigt.	Bombus veteranus
Basidiesvampe	Tofarvet foldporesvamp	DK	4	gap3	gap4	Dødt ved i løvskov	Gloeoporus dichrous
Græshopper	Stor enggræshoppe	DK	3	gap3	gap4	Fugtig eng, kontinentalt klima	Chorthippus dorsatus
Tovinger	Sort vedrovflue	DK	2	gap3	gap4	Løv saproxyl og kan lide solskin på død bøg	Laphria ephippium
Basidiesvampe	Strågul køllesvamp	DK	3	gap1	gap4	Kalkrig / lerbund	Clavaria flavipes
Karplanter	Finsk røn	DK	3	gap1	gap4	Lys skov eller skovbryn	Sorbus hybrida
Fugle	Nøddekrige	DK	2		gap4	Fyr og hassel i nåledomineret skov	Nucifraga caryocatactes
Lav-Sæksvamp	Skælklædt bægerlav	DK	3		gap4	Ren fugtig luft.	Cladonia squamosa
Edderkopper	Marmoreret hjulspinder	DK	3		gap4	Sumpskov, vand, fattigkær	Araneus marmoreus
Sæksvampe	Kæmpe-stenmorkel	DK	2	gap2	gap3	På nåletræsved i jord	Gyromitra gigas
Dagsommerfugle	Kirsebærtakvinge	DK	3	gap2	gap3	Solåbent blandet løvskovbryn	Nymphalis polychloros
Basidiesvampe	Brungul rødblad	DK	3	gap1	gap3	Sumpskov, overdrev	Entoloma formosum
Basidiesvampe	Brusk-bævretop	DK	4	gap1	gap3	Dødt ved i løvskov	Exidia cartilaginea
Basidiesvampe	Sortfodet stilkporesvamp	DK	4	gap1	gap3	Kalkrig / lerbund m. jordliggende dødt løvtræved	Polyporus melanopus
Karplanter	Kost-nellike	DK	3	gap1	gap3	Lysåbent, næringsfattigt.	Dianthus armeria
Basidiesvampe	Gulgrå køllesvamp	DK	3		gap3	Kalkrig / lerbund	Clavulinopsis cinereoides
Basidiesvampe	Bestøvlet tragthat	DK	2		gap3	Kalkrig / lerbund med nåletræ	Clitocybe alexandri
Basidiesvampe	Kliddet parasolhat	DK	4		gap3	Urørt skovjordbund i løvskov	Cystolepiota hetieri
Basidiesvampe	Hyphoderma medioburiense	DK	4		gap3	Dødt ved i gl løvskov	Hyphoderma medioburiense
Basidiesvampe	Løvegul skærmhat	DK	4		gap3	Sumpskov med dødt ved af løvtræ	Pluteus leoninus
Basidiesvampe	Rødmende alfehat	DK	34		gap3	Lysåben næringsfattig kalk- / lerbund	Porpoloma metapodium
Biller	Glat løber	DK	34		gap3	Mosdækket bund i nål/løvskov+hede	Carabus glabratus
Sommerfugle	Uldhale	DK	3		gap3	Gl krat på overdrev	Eriogaster lanestris
Biller	Azurbille	DK	24		gap3	Gl nåleskov med dødt ved	Pytho depressus
Sommerfugle	Brunrods-hætteugle	DK	3		gap3	Skovbryn	Shargacucullia scrophulariae
Lav-Sæksvamp	Kruset skjoldlav	DK	3		gap3	Ren fugtig luft.	Peltigera praetextata
Karplanter	Lav rapgræs	DK	3		gap3	Lyst, trampet, fx grusplads, græssti.	Poa supina
Sommerfugle	Gran-nonne	DK	2	gap3	gap2	Nåleskov med gran	Calliteara abietis
Basidiesvampe	Rosalilla rødblad	DK	4	gap2	gap2	Kalkrig overdrev og sumpskov	Entoloma queletii
Basidiesvampe	Tomentella lateritia	DK	4	gap2	gap2	Kalkrig / lerbund m. liggende dødt løvtræved	Tomentella lateritia
Basidiesvampe	Orangegul ridderhat	DK	23	gap2	gap2	Kalkrig / lerbund	Tricholoma aurantium
Tovinger	Stikkelsbær-glanssvirreflue	DK	3	gap2	gap2	Skovbryn	Epistrophe grossulariae
Biller	Eghjort	DK	3	gap2	gap2	Gl træer med dødt ved; Lys	Lucanus cervus
Tovinger	Tidlig ornamentsvirreflue	DK	3	gap2	gap2	Overgangszone ore, buske, bryn	Xanthogramma festivum
Lav-Sæksvamp	Elegant skållav	DK	3	gap2	gap2	Ren fugtig luft.	Melanohalea elegantula
Karplanter	Tørve-viol	DK	3	gap2	gap2	Meget våd mose m krat	Viola epipsila
Basidiesvampe	Blåfodet kødpigsvamp	DK	23	gap1	gap2	Næringsfattig skovbund, især gl nål.	Sarcodon scabrosus
Sommerfugle	Dværgspinder	DK	23	gap1	gap2	Lysåbent, næringsfattigt.	Nudaria mundana
Lav-Sæksvamp	Sprække-punktlav	DK	3	gap1	gap2	På bark af løvtræer i fugtigt miljø og ren luft	Anisomeridium polypori
Lav-Sæksvamp	Brungrøn bægerlav	DK	23	gap1	gap2	Ren fugtig luft.	Cladonia novochlorophaea
Edderkopper	Orange hjulspinder	DK	3	gap1	gap2	Sumpskov, vand, fattigkær	Araneus alsine
Basidiesvampe	Bleg rørhat	DK	3		gap2	Uforstyrret skovbund	Boletus impolitus
Basidiesvampe	Hasselporesvamp	DK	34		gap2	Levende veterantræer	Dichomitus campestris
Basidiesvampe	Tykbladet rødblad	DK	3		gap2	Lysåbent, næringsfattigt.	Entoloma clandestinum
Basidiesvampe	Firfliget stjernebold	DK	23		gap2	Kalkrig / lerbund	Geastrum quadrifidum
Basidiesvampe	Spatel-filthat	DK	4		gap2	Dødt ved i gl løvskov	Hohenbuehelia auriscalpium
Basidiesvampe	Grønskællet parasolhat	DK	4		gap2	Urørt skovjordbund i løvskov	Lepiota grangei
Basidiesvampe	Rod-gråblad	DK	23		gap2	Næringsfattig skovbund, især nål.	Lyophyllum leucophaeatum
Basidiesvampe	Orangebrun troldhat	DK	4		gap2	Klit, skov	Rhodocybe nitellina
Basidiesvampe	Violblå fagerhat	DK	34		gap2	Kalkrig / lerbund	Rugosomyces ionides
Basidiesvampe	Bævrekølle	DK	3		gap2	Kalkrig / lerbund med gl krat	Tremellodendropsis tuberosa
Sommerfugle	Grå landmand	DK	3		gap2	Lysåbent, næringsfattigt.	Acronicta cinerea
Biller	Bøgeløber	DK	34		gap2	Gammel løvskov	Carabus intricatus
Dagsommerfugle	Enghvidvinge	DK	3		gap2	Eng-skov-mix med gul fladbælg	Leptidea juvernica
Biller	Magdalis armigera	DK	34		gap2	Store levende skovelme	Magdalis armigera
Biller	Elmeloppe	DK	3		gap2	Levende elmetræer	Rhynchaenus rufus
Lav-Sæksvamp	Pudret bægerlav	DK	3		gap2	Ren fugtig luft.	Cladonia cenotea
Lav-Sæksvamp	Kvist-kantskivelav	DK	3		gap2	Ren fugtig luft.	Lecanora symmicta
Lav-Sæksvamp	Gulgrøn kantskivelav	DK	3		gap2	Ren fugtig luft.	Lecanora varia
Lav-Sæksvamp	Bark-blegskivelav	DK	3		gap2	Ren fugtig luft.	Ochrolechia androgyna
Lav-Sæksvamp	Grønpudret bogstavlav	DK	34		gap2	Ren fugtig luft.	Opegrapha herbarum
Basidiesvampe	Ædelgran-mælkehat	DK	2	gap3	gap1	Gl ædelgran på kalk/lerbund	Lactarius albocarneus
Basidiesvampe	Maj-rødblad	DK	3	gap2	gap1	Levende elmetræer	Entoloma aprile
Basidiesvampe	Højstokket ridderhat	DK	2	gap2	gap1	Gl nåleskov på kalk/lerbund	Tricholoma inamoenum
Biller	Matsort træsmælder	DK	3	gap2	gap1	Nataktiv, gl hule løvtræer inkl bøg	Crepidophorus mutilatus
Karplanter	Hvidplettet lungeurt	DK	3	gap2	gap1	Kalkrig / lerbund	Pulmonaria officinalis
Basidiesvampe	Punktstokket vokshat	DK	3	gap1	gap1	Gl krat på overdrev	Camarophyllopsis atropuncta
Basidiesvampe	Cinnober-muslingesvamp	DK	4	gap1	gap1	Dødt ved i løvskov	Crepidotus cinnabarinus

Gap-arter i scen. Q eller Q1 (N = 155).

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Bilag L

Sorteret efter truet hvor og Gap.

Artsgruppe	Artsnavn	Truet hvor	Zone	Gap_Q	Gap_Q1	Økologiske behov	Videnskabeligt navn
Basidiesvampe	Entoloma lampropus	DK	23	gap1	gap1	Lysåbent, næringsfattigt.	Entoloma lampropus
Basidiesvampe	Hypholoma ericaeum	DK	3	gap1	gap1	Lysåbent, næringsfattigt.	Hypholoma ericaeum
Basidiesvampe	Inocybe sambucina	DK	2	gap1	gap1	Uforstyrret morbund i nåleskov	Inocybe sambucina
Basidiesvampe	Glat ildporesvamp	DK	4	gap1	gap1	Dødt ved i løvskov	Phellinus laevigatus
Basidiesvampe	Brandgul fagerhat	DK	2	gap1	gap1	Kalkrig / lerbund med krat og nåletræ	Rugosomyces chrysenteron
Basidiesvampe	Lak-skørhat	DK	2	gap1	gap1	Uforstyrret morbund i nåleskov	Russula rhodopus
Basidiesvampe	Vellugtende læderporesvamp	DK	4	gap1	gap1	Sumpskov med dødt ved af løvtræ	Trametes suaveolens
Basidiesvampe	Mønster-lædersvamp	DK	4	gap1	gap1	Dødt ved på gl egetræer	Xylobolus frustulatus
Biller	Allecula morio	DK	3	gap1	gap1	Gl træer med dødt ved; Lys	Allecula morio
Sommerfugle	Brachionycha nubeculosa	DK	3	gap1	gap1	Sumpskov, birkeskov	Brachionycha nubeculosa
Tovinger	Sump-urtesvirreflue	DK	3	gap1	gap1	Sumpskov, kildevæld, mose	Cheilosia frontalis
Sommerfugle	Rødbrun ordenugle	DK	3	gap1	gap1	Lysåbent, næringsfattigt.	Cosmia affinis
Tovinger	Hvidbåndet rovflue	DK	3	gap1	gap1	Lysåbent, næringsfattigt.	Cyrtopogon lateralis
Biller	Grøn pragttorbist	DK	3	gap1	gap1	Gl træer med dødt ved; Lys	Gnorimus nobilis
Sommerfugle	Stribet målerugle	DK	3	gap1	gap1	Skovbryn	Herminia tarsicrinalis
Biller	Pragtsmælder	DK	3	gap1	gap1	Gl træer med dødt ved; Lys	Ischnodes sanguinicollis
Biller	Tachyta nana	DK	3	gap1	gap1	Gl træer med dødt ved; Lys	Tachyta nana
Lav-Sæksvamp	Tørve-bægerlav	DK	23	gap1	gap1	Ren fugtig luft.	Cladonia incrassata
Lav-Sæksvamp	Ved-nålesvamp	DK	3	gap1	gap1	Epixylisk på død rødgran	Mycocalicium subtile
Edderkopper	Midia midas	DK	3	gap1	gap1	Stabile forhold i gl skov / park	Midia midas
Karplanter	Eng-hejre	DK	3	gap1	gap1	Lysåbent, næringsfattigt.	Bromus racemosus
Basidiesvampe	Skællet fåreporesvamp	DK	34		gap1	Gl. løvskov med morbund	Albatrellus pes-caprae
Basidiesvampe	Hvidlig skiveskorpe	DK	34		gap1	Levende veterantræer	Aleurodiscus disciformis
Basidiesvampe	Athelidium aurantiacum	DK	4		gap1	Dødt ved i løvskov	Athelidium aurantiacum
Basidiesvampe	Brungul vokshat	DK	3		gap1	Gl krat på overdrev	Camarophyllopsis micacea
Basidiesvampe	Skønfodet slørhat	DK	23		gap1	Næringsfattig nåleskov	Cortinarius colus
Basidiesvampe	Safrankødet slørhat	DK	2		gap1	Næringsfattig nåleskov	Cortinarius traganus
Basidiesvampe	Pighud	DK	4		gap1	Dødt ved i løvskov	Dentipellis fragilis
Basidiesvampe	Skæv rødblad	DK	4		gap1	Dødt ved i løvskov	Entoloma depluens
Basidiesvampe	Tæge-rødblad	DK	34		gap1	Sumpskov, overdrev	Entoloma scabrosum
Basidiesvampe	Kulkantarel	DK	3		gap1	Gl. brandpletter	Faerberia carbonaria
Basidiesvampe	Grønfodet trævlhat	DK	34		gap1	Løvskov med gl træer	Inocybe calamistrata
Basidiesvampe	Stor grenkølle	DK	4		gap1	Dødt ved i gl løvskov	Lentaria epichnoa
Basidiesvampe	Thallus-navlehat	DK	34		gap1	Lysåbent, næringsfattigt.	Lichenomphalia hudsoniana
Basidiesvampe	Sej fedtporesvamp	DK	34		gap1	Gl træer med dødt ved	Spongipellis fissilis
Basidiesvampe	Steccherinum subcrinale	DK	4		gap1	Dødt ved i løvskov	Steccherinum subcrinale
Basidiesvampe	Musegrå posesvamp	DK	34		gap1	Kalkrig / lerbund	Volvariella murinella
Sommerfugle	Skinnende jordfarveugle	DK	34		gap1	Gl skov / bryn	Agrochola nitida
Biller	Tofarvet hedeløber	DK	23		gap1	Lysåbent, næringsfattigt.	Cymindis vaporariorum
Sommerfugle	Højmose-tiggerugle	DK	3		gap1	Sumpskov, højmose	Diarsia dahlii
Sommerfugle	Pragt grønsagsugle	DK	34		gap1	Sumpskov	Lacanobia splendens
Sommerfugle	Rustplettet ugle	DK	23		gap1	Lysåbent, næringsfattigt.	Lasionhada proxima
Dagsommerfugle	Skovhvidvinge	DK	3		gap1	Blomsterrig eng-skov-mix, fladbælg	Leptidea sinapis
Biller	Egeværftbille	DK	4		gap1	Solåbent dødt ved på stående eg	Lymexylon navale
Biller	Smaragdina salicina	DK	3		gap1	Lysåbent skovbryn	Smaragdina salicina
Tovinger	Temnostoma meridionale	DK	4		gap1	Dødt ved i gl løvskov	Temnostoma meridionale
Biller	Falsk skjoldbille	DK	4		gap1	Under bark og i dødt nål/løv-ved + træsvampe	Thymalus limbatus
Lav-Sæksvamp	Skov-punktlav	DK	3		gap1	Ren fugtig luft.	Anisomeridium biforme
Lav-Sæksvamp	Voksgul orangelav	DK	3		gap1	Ren fugtig luft.	Caloplaca cerina
Lav-Sæksvamp	Gulgrøn bægerlav	DK	23		gap1	Ren fugtig luft.	Cladonia carneola
Lav-Sæksvamp	Gul trådkantlav	DK	34		gap1	Ren fugtig luft.	Haematomma ochroleucum
Lav-Sæksvamp	Filtrandet kantskivelav	DK	34		gap1	Ren fugtig luft.	Lecanora intumescens
Lav-Sæksvamp	Turners blegskivelav	DK	34		gap1	Ren fugtig luft.	Ochrolechia turneri
Lav-Sæksvamp	Oliven-bogstavlav	DK	34		gap1	Ren fugtig luft.	Opegrapha vulgata
Lav-Sæksvamp	Ru prikvortelav	DK	3		gap1	Ren fugtig luft.	Pertusaria hemisphaerica
Lav-Sæksvamp	Tynd prikvortelav	DK	34		gap1	Ren fugtig luft.	Pertusaria leioplaca
Lav-Sæksvamp	Rendet grenlav	DK	23		gap1	Grene af løvtræer i fugtig ren luft	Ramalina calicaris
Lav-Sæksvamp	Gele-skivelav	DK	3		gap1	Ren fugtig luft.	Trapeliopsis gelatinosa
Lav-Sæksvamp	Almindelig skæglav	DK	23		gap1	Fugtig ren luft og rigbarks-træer	Usnea filipendula
Lav-Sæksvamp	Skæglav slægten	DK	34		gap1	Ren fugtig luft.	Usnea genus
Lav-Sæksvamp	Busket skæglav	DK	34		gap1	Ren fugtig luft.	Usnea subfloridana
Edderkopper	Stor pukkelhjulspinder	DK	2		gap1	Næringsfattig gl nåleskov	Araneus angulatus
Tovinger	Sort træsmuldsvirreflue	DK	4	gap2		Dødt ved i gl løvskov	Chalcosyrphus valgus
Basidiesvampe	Gylden grynskælhat	DK	4	gap1		Dødt ved i løvskov	Flammulaster limulatus
Basidiesvampe	Duftende kæmpeskælhat	DK	4	gap1		Sumpskov med dødt ved af løvtræ	Hemipholiota heteroclita
Basidiesvampe	Teglfarvet mælkehat	DK	2	gap1		Næringsfattig gl nåleskov	Lactarius hysginus
Basidiesvampe	Violet koralsvamp	DK	34	gap1		Gl løvskov på kalk/lerbund	Ramaria fennica
Dagsommerfugle	Rødlig perlemorsommerfugl	DK	3	gap1		Blomsterrigt eng-skov-mix med violer	Boloria euphrosyne
Tovinger	Pragtsvirreflue	DK	4	gap1		Dødt ved i gl løvskov	Caliprobola speciosa
Tovinger	Uldhåret pelssvirreflue	DK	4	gap1		Gl løvtræer m dødt ved	Criorhina floccosa
Tovinger	Smuk løgsvirreflue	DK	3	gap1		Skovbryn	Eumerus ornatus
Tovinger	Mørk myresvirreflue	DK	34	gap1		Gl træer ved højmoser	Microdon analis
Biller	Sort blomsterbuk	DK	3	gap1		Saproxyl i solåbne bøge	Stictoleptura scutellata
Sommerfugle	Trapez-glansugle	DK	3	gap1		Lysåbent, næringsfattigt.	Xestia ditrapezium
Tovinger	Lille træsvirreflue	DK	4	gap1		Dødt ved i gl løvskov	Xylota abiens
Karplanter	Kantet kohvede	DK	3	gap1		Lysåbent, næringsfattigt.	Melampyrum cristatum
Karplanter	Blåtoppet kohvede	DK	3	gap1		Kalkrig / lerbund m. slæt / heste	Melampyrum nemorosum

Bilag M

Enhed og skov	Truet	Art	Latinsk navn	Biotop	Økologiske behov	Trusler
314_110 Vilsted Sø	DK	Blomster-stængelugle	Eremobia ochroleuca	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
314_203 Halkær Mølle	DK	Olivenbrun farvetunge	Microglossum olivaceum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
314_207 Drastrup Skov	DK	Citronbjørn	Setina irrorella	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering + klima
314_207 Drastrup Skov	DK	Okkergul pletvinge	Melitaea cinxia	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
314_210 Sct Nicolai Bjerg v. Sebbers.	Globalt	Jensens vokshat	Hygrocybe ingrata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
314_210 Sct Nicolai Bjerg v. Sebbers.	DK	Gråblå rødblad	Entoloma griseocyaneum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
314_210 Sct Nicolai Bjerg v. Sebbers.	DK	Olivenbrun farvetunge	Microglossum olivaceum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
314_210 Sct Nicolai Bjerg v. Sebbers.	DK	Trichoglossum walteri (en svamp)	Trichoglossum walteri	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
314_210 Sct Nicolai Bjerg v. Sebbers.	DK	Trævlet vokshat	Hygrocybe intermedia	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
314_308 Als Havbakker	DK	Markperlemorsommerfugl	Argynnis aglaja	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_101 Klosterheden Plantage	EU	Birkemus	Sicista betulina	Åbent	Varieret blandet vegetation	Tilgroning og fragmentering
334_101 Klosterheden Plantage	DK	Engblåfugl	Cyaniris semiargus	Eng	Høslætagtig drift, blomsterrigt.	Tilgroning, eutrofier., fragmentering
334_101 Klosterheden Plantage	DK	Markperlemorsommerfugl	Argynnis aglaja	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_101 Klosterheden Plantage	DK	Spids bægerlav	Cladonia subulata	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_101 Klosterheden Plantage	DK	Spættet bredpande	Pyrgus malvae	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_101 Klosterheden Plantage	DK	Syl-firling	Sagina subulata	Kyst	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_1101 Stråsø Plantage	DK	Spættet bægerlav	Cladonia rangiformis	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_114 Arealer v. Ferring og Trans K	DK	Gråbrun vokshat	Hygrocybe fornicata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_118 Harboøre Tange	DK	Dyndløber	Carabus clathratus	Eng	Våd lavtvoksende ret fersk eng	Tilgroning og eutrofiering
334_118 Harboøre Tange	DK	Karmindompap	Carpodacus erythrinus	Åbent	Lysåbent med buske og småtræer.	ukendt
334_118 Harboøre Tange	DK	Stor kobbersneppe	Limosa limosa	Eng	Våd lavtvoksende ret fersk eng	Mangler slæt / græsning; Predation.
334_1201 Hoverdal Plantage	DK	Ensianblåfugl	Maculinea alcon	Åbent	Klokkeensian til æglægning	Tilgroning, eutrofier., fragmentering
334_1201 Hoverdal Plantage	DK	Entoloma elodes (en art svamp)	Entoloma elodes	Mose	Lysåbent, næringsfattigt, vådt.	Tilgroning og eutrofiering
334_1201 Hoverdal Plantage	DK	Gulstokket rødblad	Entoloma xanthochroum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_1201 Hoverdal Plantage	DK	Kløver-køllesværmer	Zygaena trifolii	Eng	Høslætagtig drift, blomsterrigt.	Tilgroning og eutrofiering
334_1201 Hoverdal Plantage	DK	Kortsporet blærerod	Utricularia ochroleuca	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_1201 Hoverdal Plantage	DK	Lille blåpil	Orthetrum coerulescens	Vand	Rent vand til ynglen.	ukendt
334_1201 Hoverdal Plantage	DK	Stor tornskade	Lanius excubitor	Hede	Lysåbent, næringsfattigt.	Tilgroning og lign
334_1201 Hoverdal Plantage	DK	Trehornet skarnbasse	Typhaeus typhoeus	Ore	Lysåbent, næringsfattigt, græsning.	Tilgroning og lign
334_1201 Hoverdal Plantage	DK	Uld-tuekogleaks	Trichophorum alpinum	Mose	Lysåbent, næringsfattigt, vådt.	Tilgroning og eutrofiering
334_1205 Troldhede Brunkulsleje	DK	Sen damsvirreflue	Anasimyia lunulata	Mose	Lysåbent, næringsfattigt, vådt.	Tilgroning og eutrofiering
334_1301 Fejsø Plantage	DK	Ensianblåfugl	Maculinea alcon	Åbent	Klokkeensian til æglægning	Tilgroning, eutrofier., fragmentering
334_1304 Lystbæk	DK	Kæruld-græsugle	Amphipoea lucens	Mose	Lysåbent, næringsfattigt, vådt.	Tab af vådområder
334_1401 Husby Plantage	DK	Klithede-maskesvirreflue	Paragus finitimus	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_1402 Arealer i Ringkøbing komm.	DK	Småskællet rødblad	Entoloma hispidulum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
334_1403 Arealer i Holmsland komm.	DK	Karmindompap	Carpodacus erythrinus	Åbent	Lysåbent med buske og småtræer.	ukendt
334_1403 Arealer i Holmsland komm.	DK	Klit-champignon	Agaricus devoniensis	Klit	Lysåbent, næringsfattigt.	Ophør af græsning/høslet
334_1405 Vest Stadil Fjord	EU	Brushane	Philomachus pugnax	Eng	Våd lavtvoksende ret fersk eng	Mangler slæt / græsning; Predation.
334_1405 Vest Stadil Fjord	EU	Strandtudse	Epidalea calamita	Åbent	Lavt, klart ynglevand fri for fisk.	For få gode vandhuller

Bilag M

Enhed og skov	Truet	Art	Latinsk navn	Biotop	Økologiske behov	Trusler
334_1405 Vest Stadil Fjord	DK	Sort fløjlsløber	Chlaenius tristis	Mose	Lysåbent, næringsfattigt, vådt.	ukendt
340_103 Nordskov	DK	Nordlig jordtunge	Geoglossum starbaeckii	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_103 Nordskov	DK	Sortskællet vokshat	Hygrocybe turunda	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_104 Bjørnholt	DK	Entoloma cocles (en art svamp)	Entoloma cocles	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_104 Bjørnholt	DK	Gråblå rødblad	Entoloma griseocyaneum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_104 Bjørnholt	DK	Gulfodet vokshat	Hygrocybe flavipes	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_104 Bjørnholt	DK	Hedemøgbille	Aphodius coenosus	Ore	Lysåbent, næringsfattigt, græsning.	Tilgroning og lign
340_104 Bjørnholt	DK	Mel-rødblad	Entoloma prunuloides	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_104 Bjørnholt	DK	Mørkstribet vokshat	Hygrocybe radiata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_104 Bjørnholt	DK	Nordlig jordtunge	Geoglossum starbaeckii	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_104 Bjørnholt	DK	Papil-vokshat	Hygrocybe subpapillata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_104 Bjørnholt	DK	Sortskællet vokshat	Hygrocybe turunda	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_106 Ajstrup Strand + Norsminde	DK	Vinter-stilkbovist	Tulostoma brumale	Ore	Lysåbent, næringsfattigt.	Ophør af græsning/høslet
340_212 Trustrup Høje	Globalt	Grøngul vokshat	Hygrocybe citrinovirens	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_214 Arealer på Samsø	EU	Markfirben	Lacerta agilis	Åbent	Solåben sandjord til æglægning	Tilgroning og lign
340_305 Høgdal	DK	Entoloma caesiocinctum (svamp)	Entoloma caesiocinctum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_305 Høgdal	DK	Entoloma cocles (en art svamp)	Entoloma cocles	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_305 Høgdal	DK	Gråviolet vokshat	Hygrocybe lacma	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_305 Høgdal	DK	Gulfodet vokshat	Hygrocybe flavipes	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_305 Høgdal	DK	Mørkøjet rødblad	Entoloma lividocyanulum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_305 Høgdal	DK	Nordlig jordtunge	Geoglossum starbaeckii	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_305 Høgdal	DK	Purpur-køllesvamp	Clavaria zollingeri	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_305 Høgdal	DK	Skønfodet rødblad	Entoloma corvinum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_305 Høgdal	DK	Sommer-rødblad	Entoloma solstitiale	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_305 Høgdal	DK	Trichoglossum walteri (en svamp)	Trichoglossum walteri	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_314 Dalgård	DK	Stor gødningsrovflue	Asilus crabroniformis	Ore	Lysåbent, næringsfattigt, græsning.	Tilgroning og eutrofiering
340_314 Dalgård	DK	Violetrandet ildfugl	Lycaena hippothoe	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
340_317 Ny Vissingkloster	DK	Femplettet køllesværmer	Zygaena lonicerae	Åbent	Lysåbent, næringsfattigt.	Tilgroning og lign
340_317 Ny Vissingkloster	DK	Smalrandet humlebisværmer	Hemaris tityus	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
340_401 Lysbro Skov	DK	Gråbrun vokshat	Hygrocybe fornicata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_11 Læsø Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
350_11 Læsø Plantage	DK	Argusblåfugl	Plebejus argus	Åbent	Lysåbent, næringsfattigt, lyng.	Tilgroning og eutrofiering
350_21 Skagen Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
350_21 Skagen Plantage	EU	Markfirben	Lacerta agilis	Åbent	Solåben sandjord til æglægning	Tilgroning og lign
350_21 Skagen Plantage	EU	Markpiber	Anthus campestris	Klit	Lysåbent, næringsfattigt.	Forstyrrelser, tilgron., eutrof., klima
350_21 Skagen Plantage	DK	Brun skjoldlav	Peltigera rufescens	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_21 Skagen Plantage	DK	Citronbjørn	Setina irrorella	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering + klima
350_21 Skagen Plantage	DK	Gråbåndet bredpande	Erynnis tages	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
350_21 Skagen Plantage	DK	Kappeugle	Calophasia lunula	Klit	Lysåbent, næringsfattigt.	ukendt

Bilag M

Enhed og skov		Truet	Art	Latinsk navn	Biotop	Økologiske behov	Trusler
350_21	Skagen Plantage	DK	Ruskællet rødblad	Entoloma jubatum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_21	Skagen Plantage	DK	Sne-kruslav	Flavocetraria nivalis	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_21	Skagen Plantage	DK	Svalehale	Papilio machaon	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_22	Bunken Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
350_22	Bunken Plantage	EU	Markpiber	Anthus campestris	Klit	Lysåbent, næringsfattigt.	Forstyrrelser, tilgron., eutrof., klima
350_22	Bunken Plantage	EU	Strandtudse	Epidalea calamita	Åbent	Lavt, klart ynglevand fri for fisk.	For få gode vandhuller
350_22	Bunken Plantage	DK	Almindelig skæglav	Usnea filipendula	Særl.	Fugtig ren luft og rigbarks-træer	Luftforurening
350_22	Bunken Plantage	DK	Blomster-stængelugle	Eremobia ochroleuca	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_22	Bunken Plantage	DK	Kappeugle	Calophasia lunula	Klit	Lysåbent, næringsfattigt.	ukendt
350_22	Bunken Plantage	DK	Kyst-bredfodsflue	Platycheirus immarginatus	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_23	Råbjerg Plantage	EU	Hedepletvinge	Euphydryas aurinia	Åbent	Djævelsbid til æglægning.	Tilgroning, eutrofier., fragmentering
350_23	Råbjerg Plantage	EU	Markfirben	Lacerta agilis	Åbent	Solåben sandjord til æglægning	Tilgroning og lign
350_23	Råbjerg Plantage	DK	Lav bægerlav	Cladonia humilis	Klit	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_23	Råbjerg Plantage	DK	Sortfodet bægerlav	Cladonia phyllophora	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_31	Ålbæk Plantage	EU	Hedepletvinge	Euphydryas aurinia	Åbent	Djævelsbid til æglægning.	Tilgroning, eutrofier., fragmentering
350_31	Ålbæk Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
350_31	Ålbæk Plantage	DK	Blomster-stængelugle	Eremobia ochroleuca	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_31	Ålbæk Plantage	DK	Citronbjørn	Setina irrorella	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering + klima
350_31	Ålbæk Plantage	DK	Gråbåndet bredpande	Erynnis tages	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
350_31	Ålbæk Plantage	DK	Klithede-maskesvirreflue	Paragus finitimus	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_31	Ålbæk Plantage	DK	Lyngpenselspinder	Orgyia antiquoides	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
350_31	Ålbæk Plantage	DK	Svalehale	Papilio machaon	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_31	Ålbæk Plantage	DK	Violetrandet ildfugl	Lycaena hippothoe	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
350_32	Tversted Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
350_32	Tversted Plantage	DK	Karmindompap	Carpodacus erythrinus	Åbent	Lysåbent med buske og småtræer.	ukendt
350_32	Tversted Plantage	DK	Krum star	Carex maritima	Kyst	Lysåbent, næringsfattigt.	Indsamling, klima, tilfældig uddøen.
350_32	Tversted Plantage	DK	Lav bægerlav	Cladonia humilis	Klit	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_32	Tversted Plantage	DK	Navle-stjernebold	Geastrum elegans	Ore	Lysåbent, næringsfattigt.	Tilgroning og lign
350_32	Tversted Plantage	DK	Sortbrun blåfugl	Aricia artaxerxes	Kyst	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_36	Råbjerg Mose	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
350_42	Uggerby Plantage	EU	Strandtudse	Epidalea calamita	Åbent	Lavt, klart ynglevand fri for fisk.	For få gode vandhuller
350_42	Uggerby Plantage	DK	Svalehale	Papilio machaon	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_43	Lilleheden Plantage	DK	Sortbrun blåfugl	Aricia artaxerxes	Kyst	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_43	Lilleheden Plantage	DK	Vinter-stilkbovist	Tulostoma brumale	Ore	Lysåbent, næringsfattigt.	Ophør af græsning/høslet
350_45	Tornby Plantage	EU	Løgfrø	Pelobates fuscus	Åbent	Rent ynglevandhul fri for fisk.	For få gode vandhuller
350_45	Tornby Plantage	DK	Dværgulvefod	Selaginella selaginoides	Åbent	Lysåbent, næringsfattigt, vådt.	Tilgroning og eutrofiering
350_45	Tornby Plantage	DK	Karmindompap	Carpodacus erythrinus	Åbent	Lysåbent med buske og småtræer.	ukendt
350_53	Rubjerg Plantage	DK	Kalk-vokshat	Hygrocybe calciphila	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_53	Rubjerg Plantage	DK	Pukkellæbe	Herminium monorchis	Eng	Kalkrig, ret lys næringsfattig bund	Tilgroning og eutrofiering

Bilag M

Enhed og skov		Truet	Art	Latinsk navn	Biotop	Økologiske behov	Trusler
350_53	Rubjerg Plantage	DK	Skønfodet rødblad	Entoloma corvinum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_63	Mosbjerg	DK	Blomster-stængelugle	Eremobia ochroleuca	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_63	Mosbjerg	DK	Metalvinge	Adscita statices	Åbent	Lysåbent, næringsfattigt.	Tilgroning og lign
350_69	Slettingen	DK	Vår-ærenpris	Veronica verna	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_71	Blokhus Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
350_72	Tranum Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
350_72	Tranum Plantage	DK	Engblåfugl	Cyaniris semiargus	Eng	Høslætagtig drift, blomsterrigt.	Tilgroning, eutrofier., fragmentering
350_72	Tranum Plantage	DK	Kommabredpande	Hesperia comma	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_72	Tranum Plantage	DK	Spættet bredpande	Pyrgus malvae	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
350_72	Tranum Plantage	DK	Violetrandet ildfugl	Lycaena hippothoe	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
350_78	Hune Plantage	DK	Spættet bægerlav	Cladonia rangiformis	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_13	Lyngby Hede	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
360_20	Stenbjerg Plantage, vestl. del	EU	Markfirben	Lacerta agilis	Åbent	Solåben sandjord til æglægning	Tilgroning og lign
360_20	Stenbjerg Plantage, vestl. del	DK	Klithede-maskesvirreflue	Paragus finitimus	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_20	Stenbjerg Plantage, vestl. del	DK	Lav bægerlav	Cladonia humilis	Klit	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_21	Stenbjerg Plantage, østl. del	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
360_22	Tvorup Syd	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
360_22	Tvorup Syd	EU	Tinksmed	Tringa glareola	Vand	Vandrig hede-klit-natur med fred.	Udgrøftede heder, tilgroning, klima.
360_22	Tvorup Syd	DK	Almindelig skæglav	Usnea filipendula	Særl.	Fugtig ren luft og rigbarks-træer	Luftforurening
360_22	Tvorup Syd	DK	Entoloma turci (en art svamp)	Entoloma turci	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_22	Tvorup Syd	DK	Fintornet randtæge	Coriomeris scabricornis	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_22	Tvorup Syd	DK	Gråbåndet bredpande	Erynnis tages	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
360_22	Tvorup Syd	DK	Grågul bægerlav	Cladonia zopfii	Klit	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_22	Tvorup Syd	DK	Spættet bægerlav	Cladonia rangiformis	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_22	Tvorup Syd	DK	Takket bægerlav	Cladonia crispata	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_26	Ejerslev Vang	DK	Gråbrun vokshat	Hygrocybe fornicata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_26	Ejerslev Vang	DK	Skarlagen-vokshat	Hygrocybe punicea	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_29	Legind Vejle	DK	Skarlagen-vokshat	Hygrocybe punicea	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_32	Tvorup Nord	DK	Sen damsvirreflue	Anasimyia lunulata	Mose	Lysåbent, næringsfattigt, vådt.	Tilgroning og eutrofiering
360_35	Nystrup Plantage, vestl. del	DK	Gråbrun vokshat	Hygrocybe fornicata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_35	Nystrup Plantage, vestl. del	DK	Knaldrød vokshat	Hygrocybe splendidissima	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_35	Nystrup Plantage, vestl. del	DK	Smalrandet humlebisværmer	Hemaris tityus	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_42	Kronens Hede Plantage	DK	Jordkrebs	Gryllotalpa gryllotalpa	Åbent	Lysåbent, næringsfattigt.	ukendt
360_42	Kronens Hede Plantage	DK	Violetrandet ildfugl	Lycaena hippothoe	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
360_51	Tved Plantage	DK	Brun skjoldlav	Peltigera rufescens	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_51	Tved Plantage	DK	Ensianblåfugl	Maculinea alcon	Åbent	Klokkeensian til æglægning	Tilgroning, eutrofier., fragmentering
360_51	Tved Plantage	DK	Knaldrød vokshat	Hygrocybe splendidissima	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_51	Tved Plantage	DK	Rødbrun vokshat	Hygrocybe colemanniana	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_51	Tved Plantage	DK	Røggrå køllesvamp	Clavaria fumosa	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering

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Enhed og skov		Truet	Art	Latinsk navn	Biotop	Økologiske behov	Trusler
360_53	Hanstholm Byplantage	DK	Orangegylden vokshat	Hygrocybe aurantiosplender	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_55	Vigsø rallejer	DK	Tråd-vandaks	Potamogeton filiformis	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_62	Østerild Plantage	DK	Almindelig skæglav	Usnea filipendula	Særl.	Fugtig ren luft og rigbarks-træer	Luftforurening
360_62	Østerild Plantage	DK	Ensianblåfugl	Maculinea alcon	Åbent	Klokkeensian til æglægning	Tilgroning, eutrofier., fragmentering
360_62	Østerild Plantage	DK	Smalrandet humlebisværmer	Hemaris tityus	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_73	Madsbøl Plantage	DK	Olivenbrun farvetunge	Microglossum olivaceum	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
360_83	Vester Thorup Plantage	DK	Bredbægret ensian	Gentianella campestris	Åbent	Lysåbent, næringsfattigt.	Tilgroning og lign
360_83	Vester Thorup Plantage	DK	Klitperlemorsommerfugl	Argynnis niobe	Åbent	Lysåbent, næringsfattigt.	ukendt
360_83	Vester Thorup Plantage	DK	Violetrandet ildfugl	Lycaena hippothoe	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
360_90	Kollerup Plantage	DK	Blomster-stængelugle	Eremobia ochroleuca	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
370_101	Indskovene	DK	Gråbrun vokshat	Hygrocybe fornicata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
370_101	Indskovene	DK	Siddende fontænehat	Arrhenia lobata	Åbent	Lysåbent, næringsfattigt, vådt.	Tilgroning og eutrofiering
370_101	Indskovene	DK	Skarlagen-vokshat	Hygrocybe punicea	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
370_201	Vindum Skov	DK	Blomstersiv	Scheuchzeria palustris	Mose	Lysåbent, næringsfattigt, vådt.	Tilgroning og eutrofiering
370_212	Frisenvold Laksegård	DK	Bændel-vandaks	Potamogeton compressus	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
370_221	Frydensbjerg + Katbj. Odde	DK	Skarlagen-vokshat	Hygrocybe punicea	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
370_225	Ajstrup Strand	DK	Kalk-vokshat	Hygrocybe calciphila	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
370_311	Helgenæs Syd	EU	Markfirben	Lacerta agilis	Åbent	Solåben sandjord til æglægning	Tilgroning og lign
370_316	Vænge Sø	DK	Drosselrørsanger	Acrocephalus arundinaceus	Vand	Store kraftige tagrør i søer.	ukendt
370_338	Holme strandarealer	DK	Pimpinellekøllesværmer	Zygaena minos	Ore	Lysåbent, næringsfattigt.	Tilgroning og lign
370_340	Gjerrild Strand	DK	Røggrå køllesvamp	Clavaria fumosa	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
370_340	Gjerrild Strand	DK	Stregtæge	Jalla dumosa	Åbent	Lysåbent, næringsfattigt.	Tilgroning og lign
370_401	Viborg Plantage	DK	Femplettet køllesværmer	Zygaena lonicerae	Åbent	Lysåbent, næringsfattigt.	Tilgroning og lign
370_408	Klostermarken	DK	Blomster-stængelugle	Eremobia ochroleuca	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
370_408	Klostermarken	DK	Metalvinge	Adscita statices	Åbent	Lysåbent, næringsfattigt.	Tilgroning og lign
370_408	Klostermarken	DK	Okkergul pletvinge	Melitaea cinxia	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
380_102	Sønderskoven	DK	Moserandøje	Coenonympha tullia	Mose	Højmose	Tilgroning, eutrofier., fragmentering
380_104	Arealer på Nordfur	DK	Mel-rødblad	Entoloma prunuloides	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_104	Arealer på Nordfur	DK	Mørkstribet vokshat	Hygrocybe radiata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_110	Geddal Strandenge	EU	Strandtudse	Epidalea calamita	Åbent	Lavt, klart ynglevand fri for fisk.	For få gode vandhuller
380_201	Alheden Skov	DK	Blegrød tørvelav	Icmadophila ericetorum	Mose	Lysåbent, næringsfattigt, vådt.	ukendt
380_201	Alheden Skov	DK	Spids bægerlav	Cladonia subulata	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_202	Kompedal Plantage	DK	Spættet bægerlav	Cladonia rangiformis	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_303	Søby Brunkulslejer	DK	Gråbrun vokshat	Hygrocybe fornicata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_303	Søby Brunkulslejer	DK	Lille blåpil	Orthetrum coerulescens	Vand	Rent vand til ynglen.	ukendt
380_303	Søby Brunkulslejer	DK	Rød bægerlav	Cladonia diversa	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_304	Haunstrup Brunkulslejer	DK	Okkergul pletvinge	Melitaea cinxia	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
380_305	Bøllingsø	DK	Blomster-stængelugle	Eremobia ochroleuca	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_305	Bøllingsø	DK	Højmosekvikløber	Agonum ericeti	Mose	Højmose	Tilgroning, eutrofier., fragmentering

Bilag M

Enhed og skov		Truet	Art	Latinsk navn	Biotop	Økologiske behov	Trusler
380_305	Bøllingsø	DK	Stor gødningsrovflue	Asilus crabroniformis	Ore	Lysåbent, næringsfattigt, græsning.	Tilgroning og eutrofiering
380_401	Hastrup Plantage	DK	Drosselrørsanger	Acrocephalus arundinaceus	Vand	Store kraftige tagrør i søer.	ukendt
380_402	Kilderne	Globalt	Jensens vokshat	Hygrocybe ingrata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_404	Gludsted	DK	Arktisk smaragdlibel	Somatochlora arctica	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_404	Gludsted	DK	Smalrandet humlebisværmer	Hemaris tityus	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_404	Gludsted	DK	Sort foldekantlav	Polysporina simplex	Særl.	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_404	Gludsted	DK	Takket bægerlav	Cladonia crispata	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
380_404	Gludsted	DK	Tørvemos-huesvamp	Mycena concolor	Mose	Højmose	Tilgroning og lign
514_113	Nørresø og Hestholm Kog	EU	Fjordterne	Sterna hirundo	Vand	Flydeø til rede, rent fiskerigt vand	Forstyrrelse, for få øer til rede
514_113	Nørresø og Hestholm Kog	EU	Sortterne	Chlidonias niger	Vand	Flydeø til rede; insektrigt vand.	Eutrofiering, dræning og tilgroning
514_202	Klaskeroj Skov	DK	Fjerbenet vandnymfe	Platycnemis pennipes	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
514_203	Barsbøl Skov	DK	Fjerbenet vandnymfe	Platycnemis pennipes	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
514_204	Jelssøerne	DK	Fjerbenet vandnymfe	Platycnemis pennipes	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
514_214	Stursbøl Hegn	DK	Spættet bredpande	Pyrgus malvae	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
514_302	Stensbæk Plantage	EU	Birkemus	Sicista betulina	Åbent	Varieret blandet vegetation	Tilgroning og fragmentering
514_302	Stensbæk Plantage	DK	Grågul bægerlav	Cladonia zopfii	Klit	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
514_302	Stensbæk Plantage	DK	Mariehøneedderkop	Eresus sandaliatus	Hede	Lysåbent, næringsfattigt.	Tilgroning og lign
514_302	Stensbæk Plantage	DK	Spættet bredpande	Pyrgus malvae	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
514_302	Stensbæk Plantage	DK	Trehornet skarnbasse	Typhaeus typhoeus	Ore	Lysåbent, næringsfattigt, græsning.	Tilgroning og lign
514_401	Tvismark Plantage	DK	Syl-firling	Sagina subulata	Kyst	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
514_402	Kirkeby Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
514_403	Vråby Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
514_403	Vråby Plantage	DK	Hede-glansugle	Xestia agathina	Hede	Lysåbent, næringsfattigt.	Tab af hede
514_403	Vråby Plantage	DK	Hus lav-ugle	Bryophila domestica	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
514_403	Vråby Plantage	DK	Kyst-dværg	Nola aerugula	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
514_405	Rømø Strand	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
514_405	Rømø Strand	EU	Strandtudse	Epidalea calamita	Åbent	Lavt, klart ynglevand fri for fisk.	For få gode vandhuller
514_503	Tingdal Plantage	EU	Løgfrø	Pelobates fuscus	Åbent	Rent ynglevandhul fri for fisk.	For få gode vandhuller
540_20	Klakkebjerg	DK	Blomster-stængelugle	Eremobia ochroleuca	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
540_22	Topgården	DK	Gulfodet vokshat	Hygrocybe flavipes	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
540_24	Feddet	DK	Kløver-køllesværmer	Zygaena trifolii	Eng	Høslætagtig drift, blomsterrigt.	Tilgroning og eutrofiering
540_24	Feddet	DK	Liden stjernebold	Geastrum minimum	Kyst	Lysåbent, næringsfattigt.	Ophør af græsning/høslet
540_24	Feddet	DK	Okkergul pletvinge	Melitaea cinxia	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
540_24	Feddet	DK	Vinter-stilkbovist	Tulostoma brumale	Ore	Lysåbent, næringsfattigt.	Ophør af græsning/høslet
540_25	Bobakkerne	Globalt	Grøngul vokshat	Hygrocybe citrinovirens	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
540_25	Bobakkerne	Globalt	Jensens vokshat	Hygrocybe ingrata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
540_51	Bogensø Strand	DK	Lav bægerlav	Cladonia humilis	Klit	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
540_71	Thurø Rev	EU	Mosehornugle	Asio flammeus	Åbent	Afhængig af museår og fred	Tilgroning og eutrofiering
540_72	Tåsinge Vejle	EU	Grønbroget tudse	Bufotes variabilis	Åbent	Lavt, klart vand uden planter og fisk	For få gode vandhuller

Bilag M

Enhed og skov		Truet	Art	Latinsk navn	Biotop	Økologiske behov	Trusler
540_91	Nordlangeland	DK	Lav bægerlav	Cladonia humilis	Klit	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
550_101	Nyminde Plantage, nordl. del	DK	Rød bægerlav	Cladonia diversa	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
550_102	Nyminde Plantage, sydl. del	DK	Rødlig vandaks	Potamogeton rutilus	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
550_103	Blåbjerg Plantage	DK	Moseperlemorsommerfugl	Boloria aquilonaris	Mose	Højmose	Tilgroning, eutrofier., fragmentering
550_116	Tipperne	EU	Strandtudse	Epidalea calamita	Åbent	Lavt, klart ynglevand fri for fisk.	For få gode vandhuller
550_204	Vrøgum Plantage	DK	Lyng-silke	Cuscuta epithymum	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
550_204	Vrøgum Plantage	DK	Stor tornskade	Lanius excubitor	Hede	Lysåbent, næringsfattigt.	Tilgroning og lign
550_302	Vejers Plantage, sydlige del	DK	Karmindompap	Carpodacus erythrinus	Åbent	Lysåbent med buske og småtræer.	ukendt
550_302	Vejers Plantage, sydlige del	DK	Klitperlemorsommerfugl	Argynnis niobe	Åbent	Lysåbent, næringsfattigt.	ukendt
550_302	Vejers Plantage, sydlige del	DK	Kløver-køllesværmer	Zygaena trifolii	Eng	Høslætagtig drift, blomsterrigt.	Tilgroning og eutrofiering
550_302	Vejers Plantage, sydlige del	DK	Mat skjoldlav	Peltigera malacea	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
550_303	Ål Plantage	DK	Blomster-stængelugle	Eremobia ochroleuca	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
550_303	Ål Plantage	DK	Kortsporet blærerod	Utricularia ochroleuca	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
550_303	Ål Plantage	DK	Lyngpenselspinder	Orgyia antiquoides	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
550_401	Bordrup Plantage	EU	Strandtudse	Epidalea calamita	Åbent	Lavt, klart ynglevand fri for fisk.	For få gode vandhuller
550_401	Bordrup Plantage	DK	Argusblåfugl	Plebejus argus	Åbent	Lysåbent, næringsfattigt, lyng.	Tilgroning og eutrofiering
550_401	Bordrup Plantage	DK	Ensianblåfugl	Maculinea alcon	Åbent	Klokkeensian til æglægning	Tilgroning, eutrofier., fragmentering
550_401	Bordrup Plantage	DK	Klokkelyng-ugle	Heliothis maritima	Hede	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
550_401	Bordrup Plantage	DK	Moserandøje	Coenonympha tullia	Mose	Højmose	Tilgroning, eutrofier., fragmentering
550_402	Oksby Plantage	DK	Hede-glansugle	Xestia agathina	Hede	Lysåbent, næringsfattigt.	Tab af hede
550_402	Oksby Plantage	DK	Lyng-silke	Cuscuta epithymum	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
550_403	Ho Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
550_403	Ho Plantage	DK	Hede-glansugle	Xestia agathina	Hede	Lysåbent, næringsfattigt.	Tab af hede
550_403	Ho Plantage	DK	Kløver-køllesværmer	Zygaena trifolii	Eng	Høslætagtig drift, blomsterrigt.	Tilgroning og eutrofiering
550_410	Fanø Plantage	Globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
560_101	Gødding Skov	DK	Vandstær	Cinclus cinclus	Vand	Strømrig stenet, ren å.	Vandforurening, uegnede vandløb.
560_201	Frederikshåb Plantage	EU	Løgfrø	Pelobates fuscus	Åbent	Rent ynglevandhul fri for fisk.	For få gode vandhuller
560_201	Frederikshåb Plantage	DK	Metalvinge	Adscita statices	Åbent	Lysåbent, næringsfattigt.	Tilgroning og lign
560_203	Haltrup Hede	DK	Coranarta cordigera (sommerfugl)	Coranarta cordigera	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
560_516	Harte Skov	DK	Pungmejse	Remiz pendulinus	Mose	Busket mose med dunhammer	ukendt
560_517	Troldhedebanen	EU	Birkemus	Sicista betulina	Åbent	Varieret blandet vegetation	Tilgroning og fragmentering
560_604	Tørrepladsen	DK	Vandstær	Cinclus cinclus	Vand	Strømrig stenet, ren å.	Vandforurening, uegnede vandløb.
560_606	Klingebæk	Globalt	Jensens vokshat	Hygrocybe ingrata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
560_610	Kongens Kær	DK	Pungmejse	Remiz pendulinus	Mose	Busket mose med dunhammer	ukendt
570_111	Ketting Nor	DK	Pungmejse	Remiz pendulinus	Mose	Busket mose med dunhammer	ukendt
570_111	Ketting Nor	DK	Svalehale	Papilio machaon	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
570_202	Sønderskov	DK	Drosselrørsanger	Acrocephalus arundinaceus	Vand	Store kraftige tagrør i søer.	ukendt
570_210	Mjang Dam	DK	Pungmejse	Remiz pendulinus	Mose	Busket mose med dunhammer	ukendt
570_213	Dybbøl	DK	Gråbrun vokshat	Hygrocybe fornicata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering

Bilag M

Enhed og skov	Truet	Art	Latinsk navn	Biotop	Økologiske behov	Trusler
570_502 Frøslev Plantage	DK	Lille kobbervandnymfe	Lestes virens	Vand	Ren sø med mange vandplanter.	ukendt
570_508 Søgård Skov	DK	Moseperlemorsommerfugl	Boloria aquilonaris	Mose	Højmose	Tilgroning, eutrofier., fragmentering
570_511 Areal ved Assenholm	Globalt	Jensens vokshat	Hygrocybe ingrata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
570_532 Lerskov Plantage	DK	Brun skjoldlav	Peltigera rufescens	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
570_534 Kalvø mv.	DK	Sommer-rødblad	Entoloma solstitiale	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
570_626 Slivsø	DK	Drosselrørsanger	Acrocephalus arundinaceus	Vand	Store kraftige tagrør i søer.	ukendt
724_102 Hannenov Skov	DK	Lancet-skeblad	Alisma lanceolatum	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
724_120 Albuen	EU	Grønbroget tudse	Bufotes variabilis	Åbent	Lavt, klart vand uden planter og fisk	For få gode vandhuller
724_120 Albuen	EU	Strandtudse	Epidalea calamita	Åbent	Lavt, klart ynglevand fri for fisk.	For få gode vandhuller
724_122 Lysbro Mose v. Hejrede Sø	DK	Rødhovedet and	Netta rufina	Vand	Ren sø med mange vandplanter.	For få rene søer med vandplanter.
724_129 Hyllekrog Fyr	EU	Grønbroget tudse	Bufotes variabilis	Åbent	Lavt, klart vand uden planter og fisk	For få gode vandhuller
740_102 Blykobbe Plantage	DK	Karmindompap	Carpodacus erythrinus	Åbent	Lysåbent med buske og småtræer.	ukendt
740_102 Blykobbe Plantage	DK	Skarlagen-vokshat	Hygrocybe punicea	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
740_106 Ejendommen Lassen	DK	Karmindompap	Carpodacus erythrinus	Åbent	Lysåbent med buske og småtræer.	ukendt
740_201 Hammerknuden	EU	Markfirben	Lacerta agilis	Åbent	Solåben sandjord til æglægning	Tilgroning og lign
740_201 Hammerknuden	DK	Tråd-vandaks	Potamogeton filiformis	Vand	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
740_206 Del af Ringebakkerne	DK	Karmindompap	Carpodacus erythrinus	Åbent	Lysåbent med buske og småtræer.	ukendt
740_206 Del af Ringebakkerne	DK	Pungmejse	Remiz pendulinus	Mose	Busket mose med dunhammer	ukendt
740_209 Borrelyngen	DK	Glat navlelav	Umbilicaria polyphylla	Særl.	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
740_209 Borrelyngen	DK	Kliddet navlelav	Umbilicaria deusta	Særl.	Lysåbent, næringsfattigt.	ukendt
740_209 Borrelyngen	DK	Klippe-kantskivelav	Lecanora intricata	Sten	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
740_209 Borrelyngen	DK	Knudret kraterlav	Diploschistes scruposus	Særl.	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
740_209 Borrelyngen	DK	Koral-prikvortelav	Pertusaria corallina	Særl.	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
740_209 Borrelyngen	DK	Lav bægerlav	Cladonia humilis	Klit	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
740_302 Rø Plantage	DK	Argusblåfugl	Plebejus argus	Åbent	Lysåbent, næringsfattigt, lyng.	Tilgroning og eutrofiering
740_302 Rø Plantage	DK	Engperlemorsommerfugl	Brenthis ino	Mose	Lysåbent, næringsfattigt+ mjødurt.	Tilgroning og eutrofiering
740_302 Rø Plantage	DK	Markperlemorsommerfugl	Argynnis aglaja	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
740_302 Rø Plantage	DK	Svalehale	Papilio machaon	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
750_103 Jægersborg Hegn	DK	Broget metalsvirreflue	Lejogaster tarsata	Mose	Lysåbent, næringsfattigt, vådt.	Vandforurening, dræning
750_103 Jægersborg Hegn	DK	Knaldrød vokshat	Hygrocybe splendidissima	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
750_103 Jægersborg Hegn	DK	Vandstær	Cinclus cinclus	Vand	Strømrig stenet, ren å.	Vandforurening, uegnede vandløb.
750_107 Geel Skov	DK	Svalehale	Papilio machaon	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
750_201 Jægersborg Dyrehave	Globalt	Grøngul vokshat	Hygrocybe citrinovirens	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
750_201 Jægersborg Dyrehave	Globalt	Jensens vokshat	Hygrocybe ingrata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
750_202 Rygård	DK	Gulfodet vokshat	Hygrocybe flavipes	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
750_302 Strandparken	DK	Sødgræs-stængelugle	Phragmatiphila nexa	Mose	Lysåbent, næringsfattigt, vådt.	Tilgroning og eutrofiering
750_303 Ordrup Krat	DK	Drosselrørsanger	Acrocephalus arundinaceus	Vand	Store kraftige tagrør i søer.	ukendt
750_501 Kongelunden	DK	Elme-ugle	Polymixis polymita	Åbent	Lysåben, næringsfattig + Elmetræ	ukendt
750_501 Kongelunden	DK	Karmindompap	Carpodacus erythrinus	Åbent	Lysåbent med buske og småtræer.	ukendt

Bilag M

Enhed og skov		Truet	Art	Latinsk navn	Biotop	Økologiske behov	Trusler
750_502	Vestamager	EU	Brushane	Philomachus pugnax	Eng	Våd lavtvoksende ret fersk eng	Mangler slæt / græsning; Predation.
750_502	Vestamager	EU	Grønbroget tudse	Bufotes variabilis	Åbent	Lavt, klart vand uden planter og fisk	For få gode vandhuller
750_504	Kalvebod Fælled	DK	Femplettet køllesværmer	Zygaena lonicerae	Åbent	Lysåbent, næringsfattigt.	Tilgroning og lign
750_504	Kalvebod Fælled	DK	Koralrød vokshat	Hygrocybe constrictospora	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
750_504	Kalvebod Fælled	DK	Pungmejse	Remiz pendulinus	Mose	Busket mose med dunhammer	ukendt
750_504	Kalvebod Fælled	DK	Svalehale	Papilio machaon	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
760_205	Nakke Skov	DK	Overdrevsløber	Carabus cancellatus	Ore	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
760_205	Nakke Skov	DK	Stor gødningsrovflue	Asilus crabroniformis	Ore	Lysåbent, næringsfattigt, græsning.	Tilgroning og eutrofiering
760_401	Sonnerup Skov	DK	Lyngpenselspinder	Orgyia antiquoides	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
760_401	Sonnerup Skov	DK	Rodstreg-øreugle	Spaelotis ravida	Åbent	Lysåbent, næringsfattigt.	ukendt
760_401	Sonnerup Skov	DK	Spættet bredpande	Pyrgus malvae	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
760_405	Kårup Skov	DK	Sortfodet bægerlav	Cladonia phyllophora	Hede	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
760_408	Røsnæs	EU	Markfirben	Lacerta agilis	Åbent	Solåben sandjord til æglægning	Tilgroning og lign
770_113	Ll. lyngby mose	EU	Løgfrø	Pelobates fuscus	Åbent	Rent ynglevandhul fri for fisk.	For få gode vandhuller
770_121	Holløse bredning	DK	Drosselrørsanger	Acrocephalus arundinaceus	Vand	Store kraftige tagrør i søer.	ukendt
770_121	Holløse bredning	DK	Svalehale	Papilio machaon	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
770_123	Solbjerg enge	DK	Drosselrørsanger	Acrocephalus arundinaceus	Vand	Store kraftige tagrør i søer.	ukendt
770_206	Tisvilde hegn	EU	Markfirben	Lacerta agilis	Åbent	Solåben sandjord til æglægning	Tilgroning og lign
770_209	Hyllingbjerg	DK	Plettet kongepen	Hypochoeris maculata	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
770_218	AP-Møllergrunden	DK	Liden stjernebold	Geastrum minimum	Kyst	Lysåbent, næringsfattigt.	Ophør af græsning/høslet
770_218	AP-Møllergrunden	DK	Pimpinellekøllesværmer	Zygaena minos	Ore	Lysåbent, næringsfattigt.	Tilgroning og lign
770_218	AP-Møllergrunden	DK	Stribet hedespinder	Spiris striata	Hede	Lysåbent, næringsfattigt.	Indavl og dårlig spredning.
770_301	Valby Hegn	DK	Pude-korallav	Stereocaulon evolutum	Særl.	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
770_304	Nejede vesterskov	DK	Pimpinellekøllesværmer	Zygaena minos	Ore	Lysåbent, næringsfattigt.	Tilgroning og lign
770_601	Store Dyrehave	DK	Blomstersiv	Scheuchzeria palustris	Mose	Lysåbent, næringsfattigt, vådt.	Tilgroning og eutrofiering
770_601	Store Dyrehave	DK	Tørve-nøgenhat	Psilocybe turficola	Mose	Højmose	Tilgroning og lign
770_604	Præstevang	DK	Violetrandet ildfugl	Lycaena hippothoe	Åbent	Lysåbent, næringsfattigt.	Tilgroning, eutrofier., fragmentering
770_821	Nakkehoved	DK	Bjerg-mus	Caradrina montana	Hede	Lysåbent, næringsfattigt.	ukendt
770_821	Nakkehoved	DK	Elme-ugle	Polymixis polymita	Åbent	Lysåben, næringsfattig + Elmetræ	ukendt
770_821	Nakkehoved	DK	Fætter-ugle	Protolampra sobrina	Hede	Lysåbent, næringsfattigt.	ukendt
770_821	Nakkehoved	DK	Rodstreg-øreugle	Spaelotis ravida	Åbent	Lysåbent, næringsfattigt.	ukendt
770_823	Hornbæk Plantage	DK	Elme-ugle	Polymixis polymita	Åbent	Lysåben, næringsfattig + Elmetræ	ukendt
770_823	Hornbæk Plantage	DK	Fætter-ugle	Protolampra sobrina	Hede	Lysåbent, næringsfattigt.	ukendt
770_823	Hornbæk Plantage	DK	Rodstreg-øreugle	Spaelotis ravida	Åbent	Lysåbent, næringsfattigt.	ukendt
770_825	Teglstrup Hegn	Globalt	Dolomedes plantarius (edderkop)	Dolomedes plantarius	Mose	Lysåbent, næringsfattigt, vådt.	ukendt
770_826	Egebæksvang Skov	DK	Rudret skivelav	Lecidea fuscoatra	Særl.	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
770_826	Egebæksvang Skov	DK	Stengærde-kantskivelav	Lecanora rupicola	Sten	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
770_843	Danstrup Hegn	DK	Soral-bredskivelav	Porpidia soredizodes	Særl.	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
770_843	Danstrup Hegn	DK	Stengærde-kantskivelav	Lecanora rupicola	Sten	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering

Bilag M

Enhed og skov		Truet	Art	Latinsk navn	Biotop	Økologiske behov	Trusler
770_852	Krogerup Skovene	DK	Rød skægrovflue	Eutolmus rufibarbis	Åbent	Lysåbent, næringsfattigt.	ukendt
780_205	Jonstrup Vang	DK	Klippe-porina	Porina chlorotica	Sten	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_205	Jonstrup Vang	DK	Soral-bredskivelav	Porpidia soredizodes	Særl.	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_205	Jonstrup Vang	DK	Svalehale	Papilio machaon	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_301	Vestskoven	DK	Drosselrørsanger	Acrocephalus arundinaceus	Vand	Store kraftige tagrør i søer.	ukendt
780_301	Vestskoven	DK	Gaffelsnudebille	Lixus paraplecticus	Mose	Lysåbent, næringsfattigt, vådt.	Dræning, gødskning, tilgroning
780_301	Vestskoven	DK	Pungmejse	Remiz pendulinus	Mose	Busket mose med dunhammer	ukendt
780_301	Vestskoven	DK	Småknoppet skållav	Xanthoparmelia verruculifer	Sten	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_301	Vestskoven	DK	Stengærde-kantskivelav	Lecanora rupicola	Sten	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_301	Vestskoven	DK	Svalehale	Papilio machaon	Åbent	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_402	Karlstrup Skov	EU	Grønbroget tudse	Bufotes variabilis	Åbent	Lavt, klart vand uden planter og fisk	For få gode vandhuller
780_402	Karlstrup Skov	DK	Kalk-vokshat	Hygrocybe calciphila	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_404	Regnemark	DK	Vinter-stilkbovist	Tulostoma brumale	Ore	Lysåbent, næringsfattigt.	Ophør af græsning/høslet
780_501	Tokkekøb Hegn	DK	Skarlagen-vokshat	Hygrocybe punicea	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_601	Lystrup skov	DK	Vår-ærenpris	Veronica verna	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_603	Krogenlund	DK	Broget bredskivelav	Porpidia tuberculosa	Særl.	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_603	Krogenlund	DK	Stor sandtæge	Odontoscelis fuliginosa	Åbent	Lysåbent, næringsfattigt.	Tilgroning og lign
780_604	Slagslunde skov	DK	Klippe-porina	Porina chlorotica	Sten	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
780_604	Slagslunde skov	DK	Soral-bredskivelav	Porpidia soredizodes	Særl.	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering

Type	BIOTOP (hoved biotop)
Åbent	Lidt af hvert af lysåbne typer, eller mange mulige lysåbne typer.
Klit	Klit
Eng	Eng
Hede	Hede
Kyst	Kyst
Mose	Mose
Ore	Overdrev
Sten	Sten eller klippe
Særl.	Særligt substrat

Bilag N

Truet	**Art**	**Latinsk navn**	Biotop	**Økologiske behov**	**Trusler**
EU	Birkemus	Sicista betulina	Åbent	Varieret blandet vegetation	Tilgroning og fragmentering
EU	Grønbroget tudse	Bufotes variabilis	Åbent	Lavt, klart vand uden planter og fisk	For få gode vandhuller
EU	Hedepletvinge	Euphydryas aurinia	Åbent	Djævelsbid til æglægning.	Tilgroning, eutrofier., fragmentering
EU	Løgfrø	Pelobates fuscus	Åbent	Rent ynglevandhul fri for fisk.	For få gode vandhuller
EU	Markfirben	Lacerta agilis	Åbent	Solåben sandjord til æglægning	Tilgroning og lign
EU	Mosehornugle	Asio flammeus	Åbent	Afhængig af museår og fred	Tilgroning og eutrofiering
EU	Sandterne	Gelochelidon nilotica	Åbent	Ø til rede + mix natur til fouragering	Tilfældig uddøen, forstyrrelser.
EU	Strandtudse	Epidalea calamita	Åbent	Lavt, klart ynglevand fri for fisk.	For få gode vandhuller
EU	Brushane	Philomachus pugnax	Eng	Våd lavtvoksende ret fersk eng	Mangler slæt / græsning; Predation.
EU	Engryle	Calidris alpina schinzii	Eng	Våd lavtvoksende ret fersk eng	Mangler slæt / græsning; Predation.
globalt	Hede-takspinder	Phyllodesma ilicifolia	Hede	Lysåbent, næringsfattigt.	Hård græsnings- eller brandpleje
EU	Markpiber	Anthus campestris	Klit	Lysåbent, næringsfattigt.	Forstyrrelser, tilgron., eutrof., klima
EU	Havterne	Sterna paradisaea	Kyst	Uforstyrret strand til yngel.	Færdsel på ellers uforstyrret strand
EU	Klyde	Recurvirostra avosetta	Kyst	Fredfyldt fladvand med ø til rede	Færdsel, forurening.
globalt	Dolomedes plantarius (edderkop)	Dolomedes plantarius	Mose	Lysåbent, næringsfattigt, vådt.	ukendt
EU	Fedtet krogmos	Hamatocaulis vernicosus	Mose	Lavt vådt lysåbent kær.	Tilgroning og eutrofiering
EU	Gul stenbræk	Saxifraga hirculus	Mose	Koldt rent lysåbent kildevand.	Tilgroning, eutrofiering, klima
EU	Mygblomst	Liparis loeselii	Mose	Lav lysåben kalkrig våd vegetation.	Tilgroning og eutrofiering
globalt	Grøngul vokshat	Hygrocybe citrinovirens	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
globalt	Jensens vokshat	Hygrocybe ingrata	Ore	Lysåbent, næringsfattigt.	Tilgroning og eutrofiering
EU	Sortplettet blåfugl	Maculinea arion	Ore	Timian, specialmyrer, blomsterrigt.	Tilgroning og eutrofiering
EU	Hvidbrystet præstekrave	Charadrius alexandrinus	Strand	Uforstyrret sandstrand til yngel.	Færdsel på ellers uforstyrret strand
globalt	Bred vandkalv	Dytiscus latissimus	Vand	Rene vandhuller og småsøer.	Tilgroning og eutrofiering
EU	Fjordterne	Sterna hirundo	Vand	Flydeø til rede, rent fiskerigt vand	Forstyrrelse, for få øer til rede
EU	Grøn frø	Pelophylax esculentus	Vand	Ret rene vandhuller og småsøer.	Tilgroning og eutrofiering
EU	Grøn kølleguldsmed	Ophiogomphus cecilia	Vand	Rent vand i strømrig å og bæk.	Å regulering og forurening
EU	Grøn mosaikguldsmed	Aeshna viridis	Vand	Krebseklo i rent vand.	Tilgroning og eutrofiering
EU	Klokkefrø	Bombina bombina	Vand	Lavt, klart ynglevand fri for fisk.	For få gode vandhuller
EU	Latterfrø	Pelophylax ridibundus	Vand	Ret rene vandhuller og småsøer.	Tilgroning og eutrofiering
globalt	Lys skivevandkalv	Graphoderus bilineatus	Vand	Rene vandhuller og småsøer.	Tilgroning og eutrofiering
EU	Sortterne	Chlidonias niger	Vand	Flydeø til rede; insektrigt vand.	Eutrofiering, dræning og tilgroning
EU	Tinksmed	Tringa glareola	Vand	Vandrig hede-klit-natur med fred.	Udgrøftede heder, tilgroning, klima.
EU	Vandranke	Luronium natans	Vand	Rent ret næringsfattigt vand.	Tilgroning og eutrofiering

APPENDIX I

Where are Europe's last primary forests?

Francesco Maria Sabatini, Sabina Burrascano, William S. Keeton
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Pieter Johannes Verkerk, Jürgen Bauhus, Erik Buchwald
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Tzvetan Mladenov Zlatanov, Tobias Kuemmerle

(Invited for resubmission, Diversity and Distributions)

Previous page: Ulvshale forest (photo by Erik Buchwald)

Where are Europe's last primary forests?

Short running title: Where are Europe's last primary forests?

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Abstract

Aim: Primary forests have high conservation value, serve as a reference for understanding the functioning and dynamics of natural ecosystems, but are rare in Europe due to historic deforestation and past forest management. Yet many primary forest patches remain unmapped and unprotected. Our aim was to i) compile the first European-scale map of known primary forests, ii) analyze the spatial determinants characterizing their location, and iii) locate areas where as yet unmapped primary forests are likely to occur.

Location: Europe

Methods: We aggregated data from a literature review, online questionnaires, and 32 datasets of primary forests. We used boosted regression trees to explore which biophysical, socioeconomic and forest-related variables explain the current distribution of primary forests. Finally, we predicted and mapped the relative likelihood of primary forest occurrence at a 1-km resolution across all of Europe.

Results: Data on primary forests were frequently incomplete or inconsistent among countries. Known primary forests covered 1.4 Mha in 32 countries (0.7% of Europe's forest area). Most of these forests were protected (89%), but only 46% of them strictly. Primary forests mostly occurred in mountain and boreal areas, and were unevenly distributed across countries, biogeographical regions and forest types. Unmapped primary forests likely occur in the least accessible and populated areas, where forests cover a greater share of land but wood demand historically has been low.

Main Conclusions: The current distribution of primary forests is the result of centuries of land-use dynamics and forest management. The conservation outlook for these forests is uncertain, however, since their small and fragmented patch structure makes them prone to extinction debt and human disturbance. Predicting where unmapped primary forests likely occur could aid protection efforts, especially for those countries (e.g., Romania and Slovakia) where large areas of primary forest is being lost at an alarming pace.

Keywords

Old-growth forest, primary forest, virgin forest, forest naturalness, land-use change, sustainable forest management, boosted regression trees, spatial determinants

1. Introduction

Primary forests, i.e. naturally regenerated forests of native species where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed, are becoming rare as forestland globally is cleared for agriculture or put under active management (Mackey et al., 2015; Potapov et al., 2017). Given their irreplaceability and unique qualities, protecting primary forests is a global concern (Mackey et al., 2015). Not only are they cherished for their wild nature (Navarro & Pereira, 2012), and represent a social perception of untouched nature (Schnitzler, 2014), they are also ecologically important in regions where forests are highly fragmented (Vandekerkhove et al., 2009). Primary forests, for instance, serve as refuges or sources of propagules for rare or endangered species, especially for forest species sensitive to human disturbance (Peterken, 1996; Paillet et al., 2015). Furthermore, primary forests serve as a model for understanding natural disturbance and successional dynamics (Leibundgut, 1959; Kuuluvainen & Aakala, 2011; Král et al., 2014), especially in the face of climate change, and provide baselines for the delivery of ecosystem services under unmanaged conditions, including carbon stocks and sequestration (Harmon, Ferrell & Franklin, 1990; Burrascano, Keeton, Sabatini & Blasi, 2013). Finally, primary forests help us to evaluate human impacts on forest ecosystems and to understand the potential and the limitations of close-to-nature forest management (Bauhus, Puettmann & Messier, 2009; Kuuluvainen & Aakala, 2011; EEA, 2014).

In Europe, as in other human-dominated regions, historical deforestation and forest exploitation came close to eliminating primary forests (Kaplan, Krumhardt & Zimmermann, 2009; Potapov et al., 2017). Europe’s forests are now mainly composed of semi-natural forests, while forests undisturbed by man account for only 4% of the total (FOREST EUROPE, 2015). Even this little share of undisturbed forest is heavily fragmented as no intact forest landscapes greater than 500 km^2 exist outside European Russia and boreal northern Europe (Potapov et al., 2017). Finally, although some Eastern European countries may still contain relatively large areas of primary forests (Frank et al., 2007; Kulakowski et al., 2017), these remain often unmapped and unprotected, and are being lost at an alarming rate (Knorn et al., 2013; Chylarecki & Selva, 2016).

Semi-natural forests cannot be easily restored to a primary status (Ford & Keeton, 2017). In the absence of anthropogenic disturbance, forests slowly recover the natural disturbance dynamics and develop those structural features (e.g. deadwood, large live trees, gap dynamics) that are typical for the old-growth phases of primary forests, although this process takes decades (Vandekerkhove et al., 2009; Burrascano et al., 2013; Paillet et al., 2015). The ongoing process of agricultural intensification in productive areas, which co-occurs with de-intensification or even abandonment of marginal areas, may offer important conservation opportunities (Navarro & Pereira, 2012; Schnitzler, 2014; Jepsen et al., 2015). Especially in Western Europe, satisfying wood demands increasingly relies on imports, while forests located in remote areas are today being managed much less intensively than in the past (Levers et al., 2014; Burrascano et al., 2016). As a result of these economic changes, as well as of changing management priorities, the proportion of European forests in the older age classes is increasing, although wide regional differences exist (FOREST EUROPE, 2015). Since late-successional forests are similar to primary forests in terms of conservation value, ecological functioning, and ecosystem services provisioning, efforts devoted at identifying and protecting primary forests should also include these late-successional forests, especially given that in many European regions they represent the most natural forests still existing in the landscape.

For the purpose of this study, we thus use the term '*primary forests*' (*sensu* (Buchwald, 2005), to include all forests having a high naturalness, without implying that these forests were never cleared nor disturbed by man. A growing body of knowledge about the structure and dynamics of such primary forests in Europe has accumulated recently (Keeton et al., 2010; Kuuluvainen & Aakala, 2011; Burrascano et al., 2013; EEA, 2014). This research generally focused on a few iconic primary forests, such as Białowieża in Poland, Uholka-Shyrokyi Luh in Ukraine, Žofín in the Czech Republic, and Izvoarele Nerei in Romania (Bernadzki et al., 1998; Veen et al., 2010; Král et al., 2014; Hobi, Commarmot & Bugmann, 2015). Only a few countries have systematically surveyed remaining primary forest fragments, such as the Czech Republic, Slovakia and France (Adam & Vrška, 2009; Paillet et al., 2015), yet large regional gaps remain. Transboundary efforts for mapping and protecting primary forests are rare and confined to specific ecoregions (e.g., the Carpathians, the green belt of Fennoscandia), protected areas (Parviainen et al., 2000; Frank et al., 2007) or specific forest types (e.g., UNESCO network of primeval beech forests).

Overall, little effort has been devoted to consolidating and harmonizing information at the continental scale (García Feced, Berglund & Strnad, 2015), and no up-to-date European-wide database and map of primary forests exists. As a result, systematic research to quantify the extent of primary forests in Europe, to assess whether primary forests are adequately protected, or to understand what determines their spatial distribution is missing. A map of the primary forests of Europe, is thus highly needed, to ensure that primary forests receive adequate recognition and protection (Mackey et al., 2015), and as a starting point for a systematic gap analysis that highlights those biogeographical regions or forest types for which primary forests are absent or underrepresented. Finally, analyzing the determinants of the spatial distribution of primary forests could help to indicate the pressures faced by these ecosystems, as well as candidate sites for restoration initiatives (Navarro & Pereira, 2012; Schnitzler, 2014).

In this paper, we addressed the following questions:

1) What is the current distribution of primary forests across Europe, biogeographical regions, forest types and protection levels?
2) Which biophysical, socio-economic historical land-use factors determine the extant pattern of primary forests?
3) What are the areas with the highest likelihood of finding previously unmapped primary forests?

2. Methods

Primary forest database

To produce the first map of known European primary forests, we followed the framework proposed by Buchwald (2005) that defines primary forests as "*Relatively intact forest areas that have always or at least for the past sixty to eighty years been essentially unmodified by human activity. Human impacts in such forest areas have normally been limited to low levels of hunting, fishing and harvesting of forest products, and, in some cases, to historical or pre-historical low intensity agriculture*". Our definition thus comprises all those forests previously indicated as primeval, virgin, near-virgin, old-growth and long-untouched (Buchwald, 2005).

Based on this workable definition, we conducted a literature review and collected all the studies published between January 2000 and January 2017, reporting basic information on primary forests in Europe, excluding Russia. We limited our review to papers published after 2000, to avoid including those forests that, although being reported as primary in older papers, may have meanwhile lost their primary status due to logging or other human disturbances. We identified relevant publications in the ISI Web of

Knowledge using the search term '(primary OR virgin OR old-growth OR primeval) AND forest*' in the title field. The initial search was then refined using geographical and subject areas as filters (see Supplementary material – Appendix 1 for details). This preliminary list of papers was then supplemented with literature in their own reference lists as well as with studies known to the authors. For all papers, we extracted the location and basic information on the primary forests described. In addition, we sent out a questionnaire to scientists and experts on primary forests to collect information on (i) existing maps and databases of primary forests in their country, (ii) primary forests not yet included in existing maps and databases, and (iii) contacts of additional experts. In total, we contacted 134 forest experts from 32 European countries. When a suitable dataset or map was found, we invited the data owner to join our informal network of forest scientists, and share the dataset in their possession.

All data were integrated into a geodatabase, where each primary forest patch was reported either as a polygon or as a point location. Our minimum mapping unit was 2 ha. For each forest, we gathered a set of basic descriptors, including name, location, naturalness level (following the broad definitions reported in Buchwald 2005), extent, and dominant tree species. We followed (EEA, 2006) to assign each stand to a broad forest type, based on the stand's dominant tree species, elevation, and biogeographical region (BfN, 2003). We derived the protection status and IUCN category of each forest patch based on the World Database of Protected Area (UNEP-WCMC & IUCN, 2017). A detailed description of the database architecture and of each dataset is provided in the Supporting Information (Table S1, Table S2 and Appendix 2).

Biophysical and socio-economic location characteristics of the mapped forests

Based on the variables that were previously used as spatial determinants of harvest intensity and wood production across Europe (Levers et al., 2014; Verkerk et al., 2015), we identified a set of 19 biophysical (including climate, soil, topography and forest conditions), socio-economic and historical land-use variables that could explain primary forest distribution (Table 1). Most predictors were available as raster layers with a resolution of 1x1 km or finer, with the exception of three variables that had either a 0.5° resolution, or were available at the country level. We re-projected all predictors to the Lambert Azimuthal Equal Area projection. We checked for collinearity and excluded collinear predictors when an individual variable returned a Variance Inflation Factor (VIF) greater than 10 (Dormann et al., 2013), or returned a Pearson's r >0.7 with another variable (in this case the variable having the highest VIF was excluded; Tab. 1).

Relative likelihood of the occurrence of undetected primary forests

We converted the map of primary forests to a 1-km presence-absence raster and used Boosted Regression Trees (BRTs) to explore the relationships between our set of predictors and the occurrence of primary forests in order to estimate the relative likelihood that a gridcell contained a primary forest patch. BRTs are non-parametric models based on decision trees in a boosting framework. They have the advantage of not requiring prior assumptions, of being relatively robust against overfitting, missing data, and collinearity, and thus represent a flexible approach for uncovering nonlinear relationships and interactions among predictors. BRTs are increasingly used for attaining system understanding, hypothesis testing, and statistical inferences (Elith, Leathwick & Hastie, 2008; Dormann et al., 2013). Our BRT was parameterized using a learning rate of 0.02, a tree complexity of 5, and a bag fraction of 0.7 (Elith et al., 2008). We used the *gbm.step* routine provided by the *dismo* package (Hijmans, Phillips, Leathwick & Elith, 2011) in R (R Development Core Team, 2015) to determine the optimal number of trees. All the analyses were run after masking non-forest areas as in (Gallaun et al., 2010).

Since the data on primary forest presence were spatially clustered and this may lead to inaccurate models (Phillips et al., 2009), we used a spatial filtering approach to rarefy the available data on a 5x5 km grid. To account for the bias in our dataset due to some countries not reporting any or very few data, we also created a map of sampling effort (1: high sampling effort, 0: low sampling effort; Figure S1). We selected 37,060 pseudo-absence points (i.e. ten times the number of presences after the rarefaction) in the two sampling effort classes proportionally to the presence points. To account for remaining spatial bias, we used the *pwdSample* function in the *dismo* package to pair each test presence site with the closest test pseudo-absence site prior to evaluating the performance of our model. We also tested for spatial autocorrelation in model residuals using Moran's I.

We used the receiver-operating characteristic curves (ROC) and the area under the curve (AUC) to evaluate prediction performance. Since AUC is only rank-based, we also calculated Pearson's correlation between the observed presence\pseudo-absence and the likelihood predicted from the BRT model (Phillips et al., 2009). Finally, we used the true positive and negative rates, to calculate model accuracy and precision when using different likelihood thresholds for discriminating between predicted primary forest occurrence vs. absence. The threshold returning the highest accuracy was used to create a map of the 1x1 km forested grid cell potentially containing one or more patches of primary forest. The relative importance of predictors was evaluated according to the number of times that a variable was selected for splitting, weighted by the squared improvement to the model as a result of each split, and averaged over all trees (Elith et al., 2008). For those predictors with a relative importance above that expected by chance (100%/number of predictors), we produced partial dependency plots constrained between the 2.5 and 97.5 percentiles of the predictor range and smoothed using a LOESS interpolation (span parameter = 0.2) to enhance interpretability.

3. Results

Our database covered 1.4 Mha of primary forest in 32 European countries (Fig. 1). This database was composed of 32 regional datasets (Table S2) that we integrated with data on additional 254 primary forest patches, described in 94 studies or reports retrieved through the literature review (Table S3). A list of the data sources is found in Appendix 3. Most of the primary forests were located in northern Europe, especially Finland (0.9 Mha), and Eastern Europe (0.2 Mha), especially Ukraine, Bulgaria and Romania (Table S4). The countries having the highest proportion of primary forest where Finland (2.9% of national territory), Switzerland, Lithuania, Slovenia and Bulgaria (each about 0.5%; Fig. 2). Countries for which we were not able to retrieve data on primary forests were Latvia, Belarus, Moldova and Ireland, while only scattered information was collected for Sweden, Austria, United Kingdom, Bosnia-Herzegovina, Montenegro and Serbia (Fig. 2).

Primary forests occurred mostly in the boreal (1 Mha, 1% of that biogeographical region) and the alpine regions (0.4 Mha, 0.6%). The Macaronesian region also had a high relative proportion of primary forests, all of it located in the Laurissilva of Madeira (15,100 ha, 1.5%; Table S5). The mapped primary forest patches were, on average, very small: the median size was only 24 ha, and only 4.3% of the patches were larger than 1,000 ha. Most (89.1%) of the primary forest in our dataset was protected, but only 46% was currently under strict protection (IUCN category I), with an additional 24% being included in national parks (IUCN category II; Fig. 3, Table S4).

With regards to the forest types (FTs, *sensu* EEA, 2006), boreal forest (FT1) accounted for the highest share of the mapped primary forests (1.09 Mha), followed by mountain beech forest (FT7 – 0.15 Mha), and, to a minor extent, alpine coniferous forest (FT3 – 0.07 Mha; Fig. 1, Fig. S2). According to the definitions reported in Buchwald (2005), most of the primary forests in our dataset was near-virgin (n7 – 1.20 Mha), while old-growth (n6 – 0.15 Mha) or long-untouched stands (n5 – 0.11 Mha) accounted only for a minor fraction (10%) of the cumulative area we mapped. However, when considering the number of polygons rather than the area, the highest share of the forest patches we mapped were classified as old-growth forests and belonged to the boreal (FT1), alpine coniferous (FT3) and mountain beech (FT7) forest types (Fig. S3).

The Boosted Regression Tree modeling provided insights into the relative importance of our predictors in determining the spatial patterns of known primary forests. The BRT model fitted 2,050 trees and returned a relatively high cross-validated AUC and correlation (mean ± SD range 0.86±0.005 and 0.63±0.008, respectively). When evaluating the model performance on the independent test data, the AUC and the correlation were lower (0.70 and 0.33, respectively), indicating that the model performance was affected by the spatial dependency of our data. The highest model accuracy (0.64) was observed for a threshold corresponding to the 90^{th} percentile of the probability distribution (Table S6, Fig. S4).

Biophysical, socio-economic and historical variables all played a role in determining the likelihood of primary forest occurrence (Fig. 4). Primary forests were more likely found in areas with higher ruggedness and water availability. Socio-economic factors had the highest relative importance among the selected variables, with accessibility and population density selected in 12.6% and 12.2% of all model runs. Primary forests occurred more likely farther away from major towns and where population density was lower. Both historical variables we used were important predictors: the likelihood of occurrence of primary forest decreased for increasing historical levels of wood demand up to a certain threshold, above which it increased again. The amount of land suitable for agriculture still forested in 1850, instead, showed a reverse U-shaped relationship. Finally, our model also highlighted differences across biogeographical regions: the likelihood of occurrence of primary forests was higher than average for the Alpine, Black Sea and Boreal regions.

The areas with the highest primary forest likelihood (Fig. 5) were along the Finnish-Russian and the Finnish-Swedish borders and in mountain ranges, especially the Carpathians, the eastern Alps, the Dinaric Mountains and, to lesser extent, the highest parts of the Pyrenees. Areas with low primary forests likelihood were the Atlantic region, the Britannic Archipelago, the Middle European lowlands, the Pannonian plain and the Hemiboreal Baltic region. Areas with predicted and observed primary forest (Fig. S5) matched in those regions where we had a high sampling size (N Finland, Slovakian and Ukrainian Carpathians, Balkan mountains). On the contrary, our model predicted the occurrence of scattered and isolated primary forest patches in S Finland, in the continental lowlands, or in the western Mediterranean areas weakly. Only 38% of the area predicted to host primary forest was included in protected areas, of which only 5.6% was under strict protection (i.e. IUCN category I; Fig. S6).

4. Discussion

Our study produced the most comprehensive dataset on known primary forests in Europe currently available and resulted in the first European-scale distribution map. Known primary forests covered approximately 1.4 Mha in 32 European countries, which represent 0.25% of terrestrial Europe and 0.7% of Europe's forest area excluding Russia. This extent represents only a small fraction of the 7.3 Mha of forest estimated to be *'undisturbed by man'* in Europe (FOREST EUROPE, 2015), probably as a result of differences in the definitions used (Appendix 4). We found a general increase in the number of primary forest patches from the West to the East and from the South to the North. Most of the primary forests in our dataset were located in Finland (0.9 Mha), in the Carpathians (0.16 Mha) and in the Balkans (0.08 Mha). The area for Finland is three times larger than previous estimates (FOREST EUROPE, 2015), possibly because we considered as primary forests not only stands older than 160-200 years, but also those primary forests composed of a mosaic of developmental phases still occurring in the extreme north of Finland (Kuuluvainen & Aakala, 2011; Potapov et al., 2017). On the contrary, the primary forest area mapped for the Carpathians is far lower than previously reported (0.44 Mha, (FOREST EUROPE, 2015). The data we aggregated for the Carpathians mostly derived from surveys coordinated within the framework of the UNEP – Carpathian Convention. Not only are these inventories still incomplete in countries such as Ukraine and Romania, but they also prioritize those forests having the highest naturalness levels. Therefore a considerable share of forest of lower naturalness levels, but still qualifying as primary, may remain unmapped in the Carpathians (Kulakowski et al., 2017). The low share of primary forest in Western Europe was expected considering the historically high population density, and long history of land-use, especially in the Mediterranean (Jepsen et al., 2015). Biodiversity-rich Mediterranean forest types (i.e., FT8, FT9 and FT10) were particularly scarce in our map (Fig. S2, Fig. S3), possibly also due to the relevance of fire in these ecosystems. Mediterranean fire-prone forests show fundamentally different structural characteristics from temperate mesic forests, as fire, either naturally or anthropogenically triggered, may hinder the development of structural features typically associated with old-growth stages, such as deadwood or large trees (Burrascano et al., 2013; Kulakowski et al., 2017). These features are commonly used for identifying primary forests, although they may not be suitable in the Mediterranean context, suggesting that significant portions of Mediterranean primary forest may remain overlooked for the lack of appropriate indicators of primary conditions.

Primary forest disproportionately occurred in remote, scarcely populated areas, mostly in rugged mountain areas or at high latitudes, i.e., on land with low agricultural productivity or low profitability for forestry operations. This makes intuitively sense, since accessibility and the distance from markets, or other centers of demand is one of the main drivers of land-use allocation. Indeed, in remote and unfavorable areas such as northern Fennoscandia, the Carpathians and the Balkan mountains, land-use history has been shorter and less intense than in the rest of Europe (Parviainen et al., 2000; Jepsen et al., 2015; Kulakowski et al., 2017), making the persistence of primary forests more likely. This finding is also consistent with previous work in Fennoscandia (Kuuluvainen & Aakala, 2011), as well as with the known bias in protected areas distribution towards higher elevation and more remote locations (Joppa & Pfaff, 2009). Interestingly, accessibility and population density are also important spatial determinants for explaining the patterns of wood production and harvesting intensity in Europe (Levers et al., 2014; Verkerk et al., 2015). The correlation between primary forest and water availability probably reflects the same pattern, since high water availability is usually associated with both higher mountain locations, and boreal region. Finally, our model predicted an unexpectedly high likelihood of occurrence of primary forest in the rugged portions of the Pyrenees and the Alps. The Pyrenees and the Alps have a longer history of land-use and higher historical rates of forest management intensity than other European mountain ranges, which our models could not account for.

Although difficult to treat in a spatially-explicit fashion, historical land-use pressures played a key role in our model to explain present-day primary forest distribution. Primary forests, for instance, had a lower likelihood of occurring in those regions with higher historical wood demand (Fig. 4), but only up to a threshold, after which the likelihood increased unexpectedly. We believe this relationship derives by the occurrence of several primary forest patches in some historical mining areas where a historical high wood demand co-occurred with a high historical forest cover, such as the Upper Silesian province (Poland). The historical variables we used, however, did not fully capture the role of historical events and contingencies. For instance, the occurrence of some primary forest patches may depend on the short distance from major historical political boundaries as in the case of the Bieszczady region (SE Poland) or the Rodope mountains (between Greece and Bulgaria). The peripheral location of this region and\or the historical lack of effective means for timber transportation determined the persistence of considerable areas of primary forest well into the 20th century. These areas could have followed a trajectory similar to other peripheral areas where primary forests were extensively cut in the last century if political upheavals, including the establishment of the iron curtain, did not result in their almost complete depopulation, that allowed large tracts of primary forest to persist or re-develop (Keeton et al., 2010). In addition to major historical events, peculiar local episodes could also explain the presence of some primary forest patches, such as Fonte Novello, a 50 ha old-growth stand in Gran Sasso National Park (central Italy), which is located at the boundary between two municipalities. Ownership of this forest remnant has been contented between the two municipalities since their formal establishment at the beginning of 19th century, and remains unresolved nowadays. This dispute coupled with the deep economic depression of this mountain area, saved the stand from being exploited for timber and degradation until its recent ‘rediscovery’ and protection. Other emblematic examples include primary forests that were set aside centuries ago as hunting grounds by kings or noblemen, such as in Białowieża (lowland Poland), Biogradska Gora National Park (Montenegro), or Central Bohemia (Czech Republic).

The result of an unprecedented international collaboration, our dataset should be considered as a necessary first step toward a more complete inventory. Important limitations include high variability in data quantity and quality across countries. For many countries no complete inventory exists, and data derives from the knowledge of local experts, or from partial inventories with relatively narrow breadth, focussing either on forest inside (e.g., France, Italy, Finland) or outside protected areas (e.g. Norway), or specific regions (e.g., the Transcarpathian region of Ukraine, the French Pyrenees). In some countries (e.g., Norway, Sweden, Latvia and Austria) we found only incomplete data although extensive forestry statistics and databases are generally available for these countries. For other countries with abundant forest resources and presumably also a relatively high fraction of primary forest (e.g., many Balkan countries and Belarus), data were unavailable, at least in the scientific literature or in digitized forms. In this case, we advocate a higher commitment from the international community to support local research institutions and NGOs in the collection or digitization of data on primary forests. Few data also exist for those countries with low forest cover (e.g. <10 %) and in which significant areas of primary forest are unlikely to occur due to historic clearing or biophysical factors, such as the British Isles, Moldova or Cyprus.

Granting adequate protection to European primary forests should be a conservation priority (Mackey et al., 2015), especially given the recent concerns about commercial exploitation of old-growth forests in Eastern Europe (Knorn et al., 2013; Chylarecki & Selva, 2016). The majority (89%) of primary forest in our dataset is currently under some form of protection, nevertheless its future protection remains uncertain. A high fraction of primary forests (54%) is currently found outside strictly protected areas, and broad differences exist amongst European countries in the management restriction applied in other protected areas (Parviainen et al., 2000; Verkerk, Zanchi & Lindner, 2014). In some countries, some forest management activities (e.g., salvage logging) are allowed even in protected areas, representing a threat to primary forests (Thorn et al.). Another concern is the small average size of primary forest patches. Even if protected, a small patch of forest may not be large enough to host the full range of ecological processes, and biodiversity may suffer from extinction debt (Peterken, 1996). When large patches of primary forest do not exist, maintaining existing patches in a large matrix of natural or semi-natural forests should be the priority. This is necessary both to buffer the effects of direct and indirect anthropogenic disturbance on primary forests, and because these patches could function as ‘strongholds’ for the recovery and recolonization of many specialist species in the surrounding forest (Vandekerkhove et al., 2009). Given the current low share of primary forests, their restoration should be a priority throughout Europe (Navarro & Pereira, 2012; Schnitzler, 2014). Our map could be used to prioritize those regions and forest types for possible restoration efforts. Finally, our work highlighted areas, such as the most rugged parts of the Alps and the Pyrenees, where land-use pressure is relatively low and primary forests could potentially occur, thus suggesting that the opportunity-costs of restoring primary forests and associated ecosystem processes and biodiversity in these areas may be lower than elsewhere.

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6. Cited References

Adam, D. & Vrška, T. (2009) Important localities of old-growth forests. *Landscape Atlas of the Czech Republic* (ed. by H.E. Al.), p. 209. Ministry of Environment and Silva Tarouca Research Institute.

Bauhus, J., Puettmann, K. & Messier, C. (2009) Silviculture for old-growth attributes. *Forest Ecology and Management*, **258**, 525-537.

Bernadzki, E., Bolibok, L., Brzeziecki, B., Zącaczkowski, J. & Zybura, H. (1998) Compositional dynamics of natural forests in the Bialowieza National Park, northeastern Poland. *Journal of Vegetation Science*, **9**, 229-238.

BfN (2003) Map of natural vegetation of Europe. Bundesamt fur Naturschutz, Deutschland. Available at: http://www.bfn.de/. National data included. In:

Buchwald, E. (2005) A hierarchical terminology for more or less natural forests in relation to sustainable management and biodiversity conservation. *Proceedings: Third expert meeting on harmonizing forest-related definitions for use by various stakeholders* Food and Agriculture Organization of the United Nations, Rome, 17-19 January 2005.

Burrascano, S., Keeton, W.S., Sabatini, F.M. & Blasi, C. (2013) Commonality and variability in the structural attributes of moist temperate old-growth forests: A global review. *Forest Ecology and Management*, **291**, 458-479.

Burrascano, S., Chytrý, M., Kuemmerle, T., Giarrizzo, E., Luyssaert, S., Sabatini, F.M. & Blasi, C. (2016) Current European policies are unlikely to jointly foster carbon sequestration and protect biodiversity. *Biological Conservation*, **201**, 370-376.

Busetto, L., Barredo, J. & San-Miguel-Ayanz, J. (2014) Developing a Spatially-Explicit Pan-European Dataset of Forest Biomass Increment.

Chylarecki, P. & Selva, N. (2016) Ancient forest: spare it from clearance. *Nature*, **530**, 419-419.

Dormann, C.F., Elith, J., Bacher, S., Buchmann, C., Carl, G., Carré, G., Marquéz, J.R.G., Gruber, B., Lafourcade, B. & Leitão, P.J. (2013) Collinearity: a review of methods to deal with it and a simulation study evaluating their performance. *Ecography*, **36**, 27-46.

EEA (2006) European forest types. Categories and types for sustainable forest management reporting and policy. In. EEA Technical Report No 9/2006. EEA, Copenhagen.
EEA (2014) *Developing a forest naturalness indicator for Europe. Concept and methodology for a high nature value (HNV) forest indicator*. EEA Technical report No 13/2014, Luxembourg: Publications Office of the European Union.
Elith, J., Leathwick, J.R. & Hastie, T. (2008) A working guide to boosted regression trees. *Journal of Animal Ecology*, **77**, 802-813.
Ford, S.E. & Keeton, W.S. (2017) Enhanced carbon storage through management for old-growth characteristics in northern hardwood-conifer forests. *Ecosphere*, **8**
FOREST EUROPE (2015) State of Europe's Forests 2015.
Frank, G., Parviainen, J., Vandekerhove, K., Latham, J., Schuck, A. & Little, D. (2007) *COST Action E27. Protected Forest Areas in Europe-analysis and harmonisation (PROFOR): results, conclusions and recommendations*. Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW).
Gallaun, H., Zanchi, G., Nabuurs, G.-J., Hengeveld, G., Schardt, M. & Verkerk, P.J. (2010) EU-wide maps of growing stock and above-ground biomass in forests based on remote sensing and field measurements. *Forest Ecology and Management*, **260**, 252-261.
García Feced, C., Berglund, H. & Strnad, M. (2015) Scoping document: information related to European old growth forests. ETC/BD report to the EEA. In:
Harmon, M.E., Ferrell, W.K. & Franklin, J.F. (1990) Effects on carbon storage of conversion of old-growth forests to young forests. *Science*, **247**, 699-702.
Hijmans, R.J., Phillips, S., Leathwick, J. & Elith, J. (2011) *Package 'dismo'. Available online at: http://cran.r-project.org/web/packages/dismo/index.html*.
Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G. & Jarvis, A. (2005) Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology*, **25**, 1965-1978.
Hobi, M.L., Commarmot, B. & Bugmann, H. (2015) Pattern and process in the largest primeval beech forest of Europe (Ukrainian Carpathians). *Journal of Vegetation Science*, **26**, 323-336.
Jepsen, M.R., Kuemmerle, T., Müller, D., Erb, K., Verburg, P.H., Haberl, H., Vesterager, J.P., Andrič, M., Antrop, M., Austrheim, G., Björn, I., Bondeau, A., Bürgi, M., Bryson, J., Caspar, G., Cassar, L.F., Conrad, E., Chromý, P., Daugirdas, V., Van Eetvelde, V., Elena-Rosselló, R., Gimmi, U., Izakovicova, Z., Jančák, V., Jansson, U., Kladnik, D., Kozak, J., Konkoly-Gyuró, E., Krausmann, F., Mander, Ü., McDonagh, J., Pärn, J., Niedertscheider, M., Nikodemus, O., Ostapowicz, K., Pérez-Soba, M., Pinto-Correia, T., Ribokas, G., Rounsevell, M., Schistou, D., Schmit, C., Terkenli, T.S., Tretvik, A.M., Trzepacz, P., Vadineanu, A., Walz, A., Zhllima, E. & Reenberg, A. (2015) Transitions in European land-management regimes between 1800 and 2010. *Land Use Policy*, **49**, 53-64.
Joppa, L. & Pfaff, A. (2009) High and far: biases in the location of protected areas. *PLoS ONE*, **4**, e8273.
Kaplan, J.O., Krumhardt, K.M. & Zimmermann, N. (2009) The prehistoric and preindustrial deforestation of Europe. *Quaternary Science Reviews*, **28**, 3016-3034.
Keeton, W.S., Chernyavskyy, M., Gratzer, G., Main-Knorn, M., Shpylchak, M. & Bihun, Y. (2010) Structural characteristics and aboveground biomass of old-growth spruce-fir stands in the eastern Carpathian mountains, Ukraine. *Plant Biosystems*, **144**, 148-159.
Kempeneers, P., Sedano, F., Seebach, L., Strobl, P. & San-Miguel-Ayanz, J. (2011) Data fusion of different spatial resolution remote sensing images applied to forest-type mapping. *IEEE Transactions on Geoscience and Remote Sensing*, **49**, 4977-4986.
Knorn, J., Kuemmerle, T., Radeloff, V.C., Keeton, W.S., Gancz, V., Biriş, I.A., Svoboda, M., Griffiths, P., Hagatis, A. & Hostert, P. (2013) Continued loss of temperate old-growth forests in the Romanian Carpathians despite an increasing protected area network. *Environmental Conservation*, **40**, 182-193.
Král, K., McMahon, S.M., Janík, D., Adam, D. & Vrška, T. (2014) Patch mosaic of developmental stages in central European natural forests along vegetation gradient. *Forest Ecology and Management*, **330**, 17-28.

Kulakowski, D., Seidl, R., Holeksa, J., Kuuluvainen, T., Nagel, T.A., Panayotov, M., Svoboda, M., Thorn, S., Vacchiano, G. & Whitlock, C. (2017) A walk on the wild side: disturbance dynamics and the conservation and management of European mountain forest ecosystems. *Forest Ecology and Management*, **388**, 120-131.
Kuuluvainen, T. & Aakala, T. (2011) Natural forest dynamics in boreal Fennoscandia: a review and classification. *Silva Fennica*, **45**, 823-841.
Leibundgut, H. (1959) *Über Zweck und Methodik der Struktur-und Zuwachsanalyse von Urwäldern*.
Levers, C., Verkerk, P.J., Müller, D., Verburg, P.H., Butsic, V., Leitão, P.J., Lindner, M. & Kuemmerle, T. (2014) Drivers of forest harvesting intensity patterns in Europe. *Forest Ecology and Management*, **315**, 160-172.
Mackey, B., DellaSala, D.A., Kormos, C., Lindenmayer, D., Kumpel, N., Zimmerman, B., Hugh, S., Young, V., Foley, S., Arsenis, K. & Watson, J.E.M. (2015) Policy Options for the World's Primary Forests in Multilateral Environmental Agreements. *Conservation Letters*, **8**, 139-147.
McCune, B. & Keon, D. (2002) Equations for potential annual direct incident radiation and heat load. *Journal of Vegetation Science*, **13**, 603-606.
McGrath, M., Luyssaert, S., Meyfroidt, P., Kaplan, J., Bürgi, M., Chen, Y., Erb, K., Gimmi, U., McInerney, D. & Naudts, K. (2015) Reconstructing European forest management from 1600 to 2010. *Biogeosciences*, **12**, 4291-4316.
NASA (2006) Shuttle Radar Topography Mission. <http://www.jpl.nasa.gov/srtm> (accessed 01.09.16). In:
Navarro, L.M. & Pereira, H.M. (2012) Rewilding abandoned landscapes in Europe. *Ecosystems*, **15**, 900-912.
Nelson, A. (2008) Travel time to major cities: A global map of Accessibility. In: (ed. I.I.a.a.H.G.J.E.E.E. Global Environment Monitoring Unit - Joint Research Centre of the European Commission)
Oak Ridge National Laboratory (2005) High resolution global population dataset. In:
Paillet, Y., Pernot, C., Boulanger, V., Debaive, N., Fuhr, M., Gilg, O. & Gosselin, F. (2015) Quantifying the recovery of old-growth attributes in forest reserves: a first reference for France. *Forest Ecology and Management*, **346**, 51-64.
Parviainen, J., Bücking, W., Vandekerkhove, K., Schuck, A. & Päivinen, R. (2000) Strict forest reserves in Europe: efforts to enhance biodiversity and research on forests left for free development in Europe(EU-COST-Action E 4). *Forestry*, **73**, 107-118.
Peterken, G.F. (1996) Natural woodland: ecology and conservation in northern temperate regions. *Natural woodland: ecology and conservation in northern temperate regions.* Cambridge University Press, Cambridge UK.
Phillips, S.J., Dudík, M., Elith, J., Graham, C.H., Lehmann, A., Leathwick, J. & Ferrier, S. (2009) Sample selection bias and presence-only distribution models: implications for background and pseudo-absence data. *Ecological Applications*, **19**, 181-197.
Potapov, P., Hansen, M.C., Laestadius, L., Turubanova, S., Yaroshenko, A., Thies, C., Smith, W., Zhuravleva, I., Komarova, A., Minnemeyer, S. & Esipova, E. (2017) The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013. *Science Advances*, **3**
R Development Core Team (2015) *R: A language and environment for statistical computing* R Foundation for Statistical Computing.
Schnitzler, A. (2014) Towards a new European wilderness: Embracing unmanaged forest growth and the decolonisation of nature. *Landscape and Urban Planning*, **126**, 74-80.
Soille, P. & Vogt, P. (2009) Morphological segmentation of binary patterns. *Pattern recognition letters*, **30**, 456-459.
Thorn, S., Bässler, C., Brandl, R., Burton, P.J., Cahall, R., Campbell, J.L., Castro, J., Choi, C.-Y., Cobb, T., Donato, D.C., Durska, E., Fontaine, J.B., Gauthier, S., Hebert, C., Hothorn, T., Hutto, R.L., Lee, E.-J., Leverkus, A.B., Lindenmayer, D.B., Obrist, M.K., Rost, J., Seibold, S., Seidl, R., Thom, D., Waldron, K., Wermelinger, B., Winter, M.-B.,

Zmihorski, M. & Müller, J. (*in press*) Impacts of salvage logging on biodiversity: a meta-analysis. *Journal of Applied Ecology*, n/a-n/a.
Trabucco, A. & Zomer, R.J. (2010) Global Soil Water Balance Geospatial Database. CGIAR Consortium for Spatial Information. In, Published online, available from the CGIAR-CSI GeoPortal at: http://www.cgiar-csi.org.
UNEP-WCMC & IUCN (2017) *Protected Planet: The World Database on Protected Areas (WDPA)* Available at: www.protectedplanet.net (accessed March 2017).
Vandekerkhove, K., De Keersmaeker, L., Menke, N., Meyer, P. & Verschelde, P. (2009) When nature takes over from man: Dead wood accumulation in previously managed oak and beech woodlands in North-western and Central Europe. *Forest Ecology and Management*, **258**, 425-435.
Veen, P., Fanta, J., Raev, I., Biriş, I.-A., de Smidt, J. & Maes, B. (2010) Virgin forests in Romania and Bulgaria: results of two national inventory projects and their implications for protection. *Biodiversity and Conservation*, **19**, 1805-1819.
Verkerk, P.J., Zanchi, G. & Lindner, M. (2014) Trade-offs between forest protection and wood supply in Europe. *Environmental management*, **53**, 1085.
Verkerk, P.J., Levers, C., Kuemmerle, T., Lindner, M., Valbuena, R., Verburg, P.H. & Zudin, S. (2015) Mapping wood production in European forests. *Forest Ecology and Management*, **357**, 228-238.
Zabel, F., Putzenlechner, B. & Mauser, W. (2014) Global agricultural land resources–a high resolution suitability evaluation and its perspectives until 2100 under climate change conditions. *PloS one*, **9**, e107522.

7. Data Accessibility

The data on primary forests here presented were collected within the F&CO-NET initiative, and remain property of the institutions, organizations or person who created or collected them. The custodian of each dataset, i.e. person who owns or represents the contributed data, is listed in Table S2. F&CO-NET is available on request for disclosing data to individuals or groups of individuals for research or application purposes. Requests will be considered by the F&CO-NET coordinator (F.M. Sabatini, T. Kuemmerle) and data released after receiving the approval from the respective custodians. All derived data are available upon request from the corresponding author.

8. Biosketch

Francesco Maria Sabatini focuses on the processes and determinants underlying the distribution of plant biodiversity in forests. Most of his research has been on old-growth and virgin forests since these represent reference systems for understanding baselines and processes related to natural disturbance regimes and forest dynamics, tree demography, and carbon cycling.

9. Tables

See next page.

Table 1 - Description of single predictors, as grouped in classes. For each predictor, we reported the measurement unit, resolution (Res), data source, the sign of the expected relationship with the likelihood of occurrence of primary forests (+ positive, - negative), and data format. (R – raster, V – vector). Only underlined variables were retained in the final model.

Class	**Predictor**	**Description**	**Mes. unit**	**Res**	**Source**	**Expected** relationship	For-mat
Climate	*Growing degree days (GDD)*	Num. days per year having a mean temp > 5°C	days	30 arc secs	(Hijmans et al., 2005)	-	R
	Mean Annual Temperature	Long Term mean annual temperature	°C	30 arc secs	(Hijmans et al., 2005)	-	R
	Water availability	Priestly-Taylor coefficient: difference between precipitation and potential evapo-transpiration	ratio	30 arc secs	(Trabucco & Zomer, 2010)	+	R
Soil	*Crop suitability*	Maximum suitability value across 16 crops.	0-1	30 arc secs	(Zabel, Putzen-lechner & Mauser, 2014)	-	R
Topography	Elevation	Elevation a.s.l.	m	30 arc secs	(NASA, 2006)	+	R
	Slope		%	30 arc secs	(NASA, 2006)	+	R
	Aspect		°	30 arc secs	(NASA, 2006)	±	R
	Ruggedness	Terrain ruggedness expressing relief energy	m	30 arc secs	(NASA, 2006)	+	R
	Solar Radiation	Potential annual direct incident radiation	log (MJ cm^{-2} $*yr^{-1}$)	1km	(McCune & Keon, 2002)	-	R
Forest Conditions	*Forest Cover*	Percentage of forested area	%	1 km	(Kempeneers et al., 2011)	+	R
	Forest Core area	Percentage of forested area classified as core	%	1 km	(Soille & Vogt, 2009)	+	R
	Growing stock		m^3/ha	1 km	(Gallaun et al., 2010)	+	R
	Net annual increment	Annual aboveground biomass increment	Ton d.m.* $ha^{-1}*yr^{-1}$	1km	(Busetto, Barredo & San-Miguel-Ayanz, 2014)	-	R
	Biogeograhical region		dummy		(BfN, 2003)		V
Socio-economic	*Population density*	Landscan dataset	n/km^2	30 arc secs	(Oak Ridge National Labo-ratory, 2005)	-	R
	Travel Time to the nearest city	Estimated travel time to the nearest city of 50,000 or more people in year 2000	min	1 km	(Nelson, 2008)	+	R
	Harvest intensity (2000-2015 average)	Percentage of net annual increment harvested in 2000	%	Count ry	(FOREST EUROPE, 2015)	-	V
Historical legacies	*Forested Cover (1850)*	Amount of land suitable for agriculture still forested in 1850	%	Count ry	(Kaplan et al., 2009)	+	V
	Wood demand (1828)	Historical wood demand reconstructed for 1828	TgC	0.5 °	(McGrath et al., 2015)	-	R

10. Figures

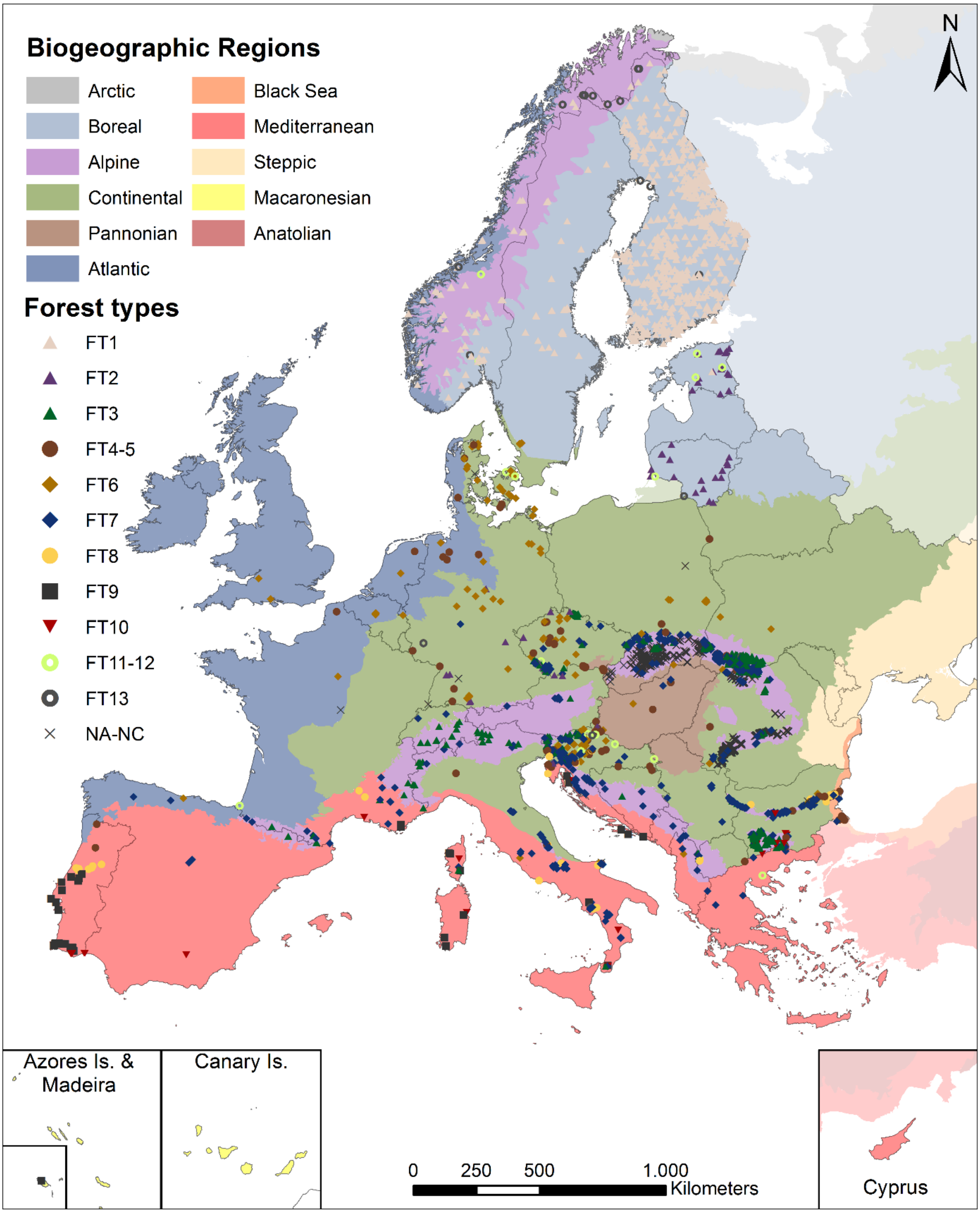

Figure 1 - Distribution of primary forest patches retrieved for Europe by forest type. The map of biogeographical regions in the background follows (BfN, 2003). Forest types follow (EEA, 2006): FT1- Boreal forest, FT2 - Hemiboreal and nemoral coniferous-mixed forest, FT3 - Alpine coniferous, FT4-5 - Mesophytic deciduous & acidophilous forest, FT6 – Beech forest, FT7 - Mountainous beech forest, FT8 - Thermophilous deciduous forest, FT9 - Broadleaved evergreen forest; FT10 - Coniferous Mediterranean forest; FT11-12 – Mire and swamp forests & Floodplain forest, FT13 - Non-riverine alder, birch or aspen, NA-NC - NoData/Unclassified.

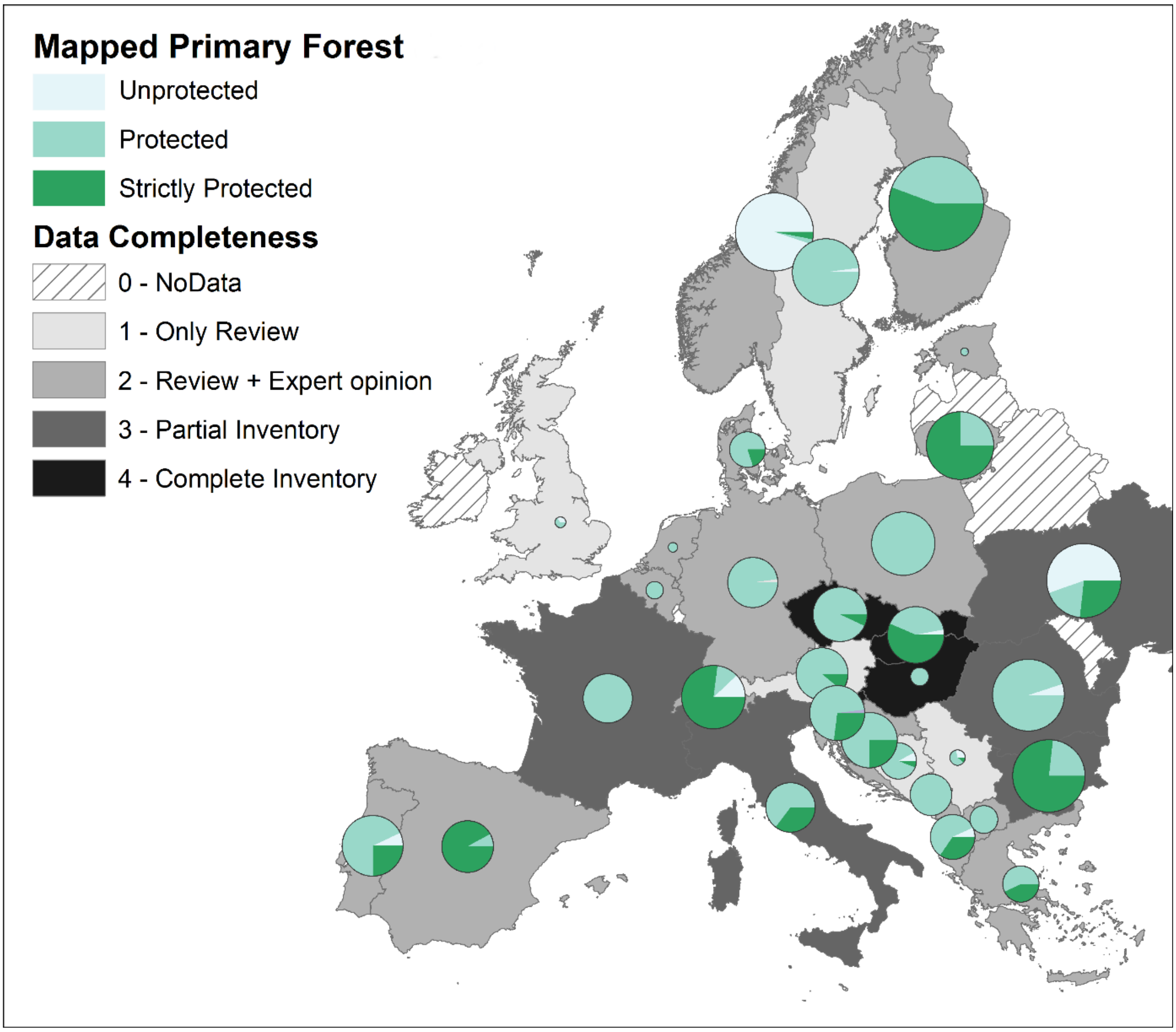

Figure 2 – Amount of primary forest mapped in each country, and proportion of primary forest under strict protection (IUCN category I), included in protected areas having other IUCN categories, or unprotected. The size of the pie is proportional to the logarithm of the total primary forest extent mapped in a country. The pie fractions only represent the data currently available and they should not be directly compared across countries, as data quality and availability is not comparable. Furthermore, for some countries only inventories of primary forest located either inside (e.g. Italy, Finland, France) or outside (Norway) protected areas were available.

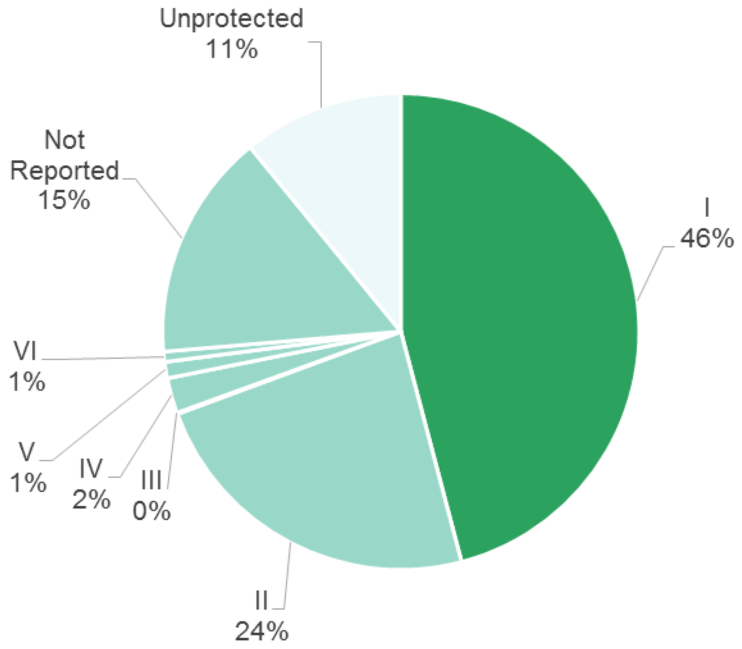

Figure 3 - Area of European primary forest across IUCN categories . I – Strict Nature Reserves or Wilderness Areas; II – National Parks; III – Natural Monuments or features; IV - Habitat/Species Management Areas; V - Protected Landscapes; VI - Protected area with sustainable use of natural resources. When a patch of primary forest was protected under multiple levels, we only considered the strictest category.

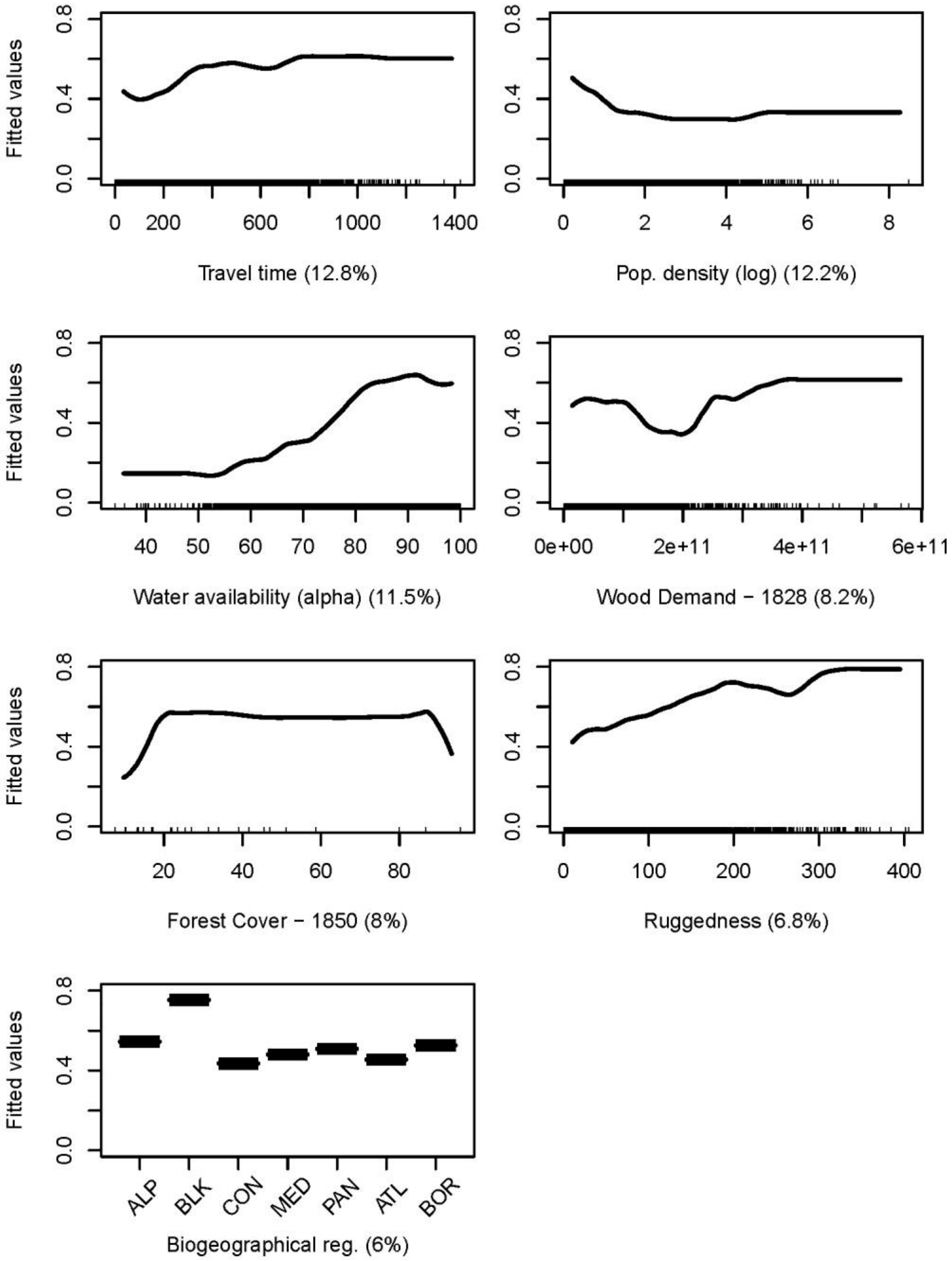

Figure 4 – Partial Dependency Plots (PDPs) showing the relationship between spatial determinants and the relative likelihood of occurrence of primary forest patches in a given 1x1 km pixel. The vertical axis of the PDPs shows fitted values for each observation along the variable's data range (horizontal axis). X-axes are equipped with rug plots that visualise the distribution of the respective data space. Numbers in parentheses represent the relative importance of a given variable. Biogeographical regions: ALP=Alpine, BLK=Black Sea, CON=Continental, MED=Mediterranean, PAN=Pannonian, ATL=Atlantic, BOR=Boreal).

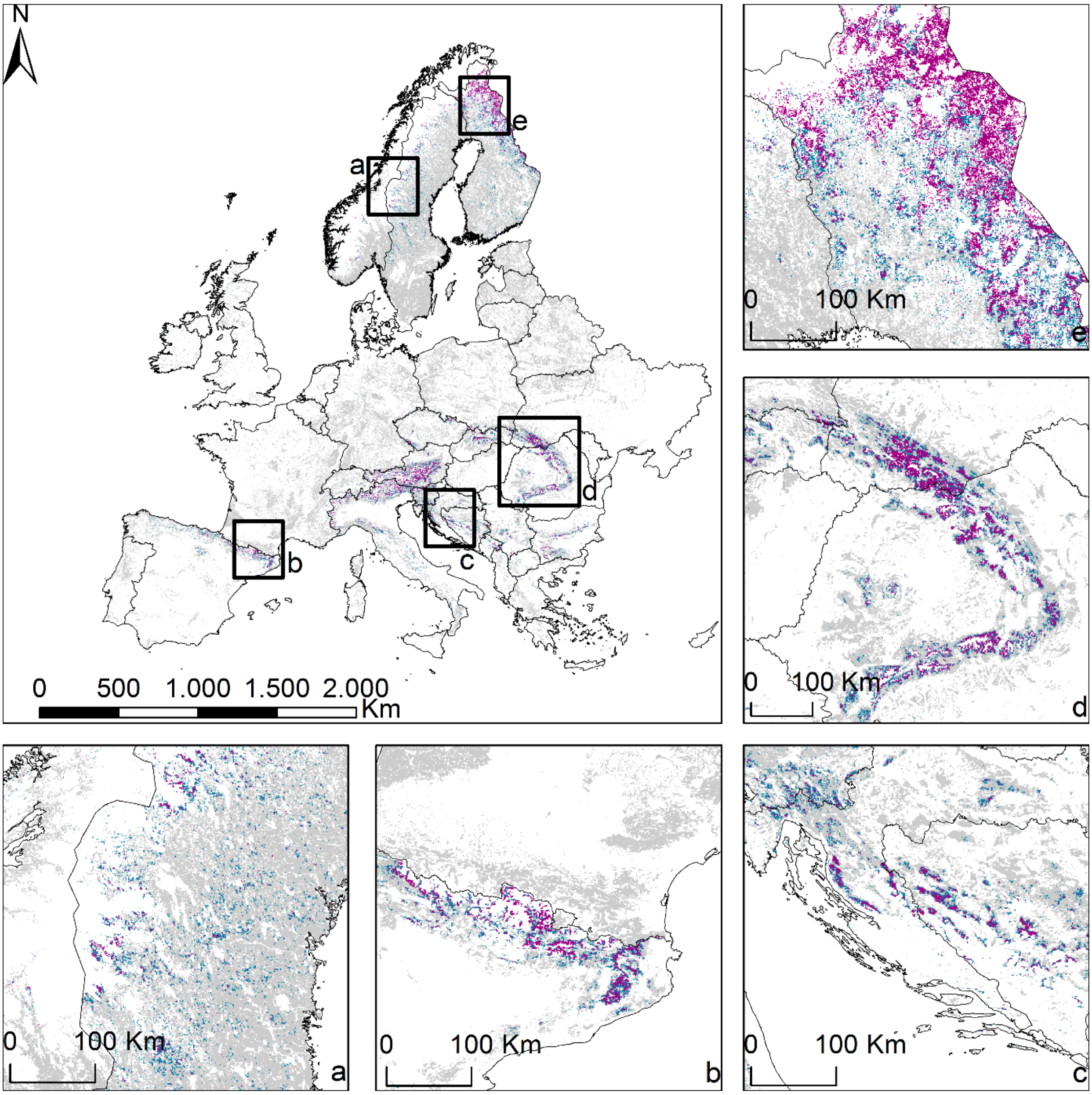

Figure 5 – Pixels showing the highest likelihood of occurrence of primary forest in Europe at a 1 x 1 km resolution. The top ranking 5% pixels were highlighted in purple, and the 90-95th percentile in blue. Forests are reported in grey and follow (Gallaun et al., 2010).

11. Supplementary material

Appendix 1 – Literature review query.

Appendix 2 – Primary forest datasets factsheets.

Appendix 3 – Data sources of literature review.

Appendix 4 – Definition framework.

Table S1 – Geodatabase architecture.

Table S2 – Summary of primary forest datasets collected.

Table S3 – Results of literature review.

Table S4 – Summary of primary forest extent by country.

Table S5 – Summary of primary forest extent by biogeographical region.

Table S6 – Summary of BRT accuracy and precision for increasing likelihood thresholds.

Figure S1 – Fraction of the study area were systematic inventories of primary forests were performed (bias mask).

Figure S2 – Barplot of primary forest area per forest type and naturalness level.

Figure S3 – Barplot of primary forest patches (counts) per forest type and naturalness level.

Figure S4 – Precision and accuracy of BRT model for increasing thresholds of relative likelihoods.

Figure S5 – Map of congruency between predicted (top 10^{th} percentile) and observed primary forests.

Figure S6 – Map of the protections status of the areas predicted to host primary forests.

Appendix 1 – Literature review query

#Supplementary material to the paper:
Sabatini et al. 2017
Where are Europe's last primary forests?
Submitted to: Diversity and Distribution

Research query in Web of Knowledge, advanced search

TI= (Primary OR Virgin OR old-growth OR Primeval)
AND
TI= Forest*
AND
TS=(Europ* OR Austria OR Belgium OR Bulgaria OR Croatia OR Cyprus OR Czech Republic OR Denmark OR Estonia OR Finland OR France OR Germany OR Greece OR Hungary OR Ireland OR Italy OR Latvia OR Lithuania OR Luxembourg OR Malta OR Netherlands OR Poland OR Portugal OR Romania OR Slovakia OR Slovenia OR Spain OR Sweden OR United Kingdom OR Norway OR Switzerland OR Ukraine OR Bosnia OR Serbia OR Montenegro OR Albania OR Belarus)
AND
SU= (ENVIRONMENTAL SCIENCES ECOLOGY OR FORESTRY OR ZOOLOGY OR BIODIVERSITY CONSERVATION OR PLANT SCIENCES OR GEOGRAPHY OR EVOLUTIONARY BIOLOGY OR REMOTE SENSING)

Appendix 2 - Primary forest datasets factsheets

Dataset 1

DATASET NAME	*Forest Ecology Group CULS*
Name	Mikoláš, Martin
e-mail address	martin.ozprales@gmail.com
Affiliation and contacts	Czech University of Life Sciences Faculty of Forestry and Wood Sciences Department of Forest Ecology Kamýcka 129 Praha 6 Suchdol 16521 Czech Republic
Title of the Dataset	Shapefile describing the distribution of primary forests surveyed by the Forest Ecology Group CULS
Data Type	MAP
Data Coverage - Region(s) covered	Albania, Romania, Ukraine
Data Completeness	PARTIAL SURVEY
Update status	2016
Object of the dataset	1. dendrochronological research - establishment of permanent study plots and analyses of the natural disturbance regimes 2. We refer to forest remnants included in the dataset as forest with minimal signs of direct human impact which structure, composition and processes resulted from natural disturbances.
Methodological approach	These stands were surveyed for the indicators of the naturalness (e.g. course woody debris in various stages of decay, presence of old trees) and signs of human impact, stands with evidence of past logging and grazing were avoided. Further, we searched all available archival information regarding the history of land use in these areas. In these stands, permanent study plots have been established and dendrochronological data have been collected. Published papers : Ukraine dataset: Trotsiuk, V., Svoboda, M., Janda, P., Mikolas, M., Bace, R., Rejzek, J., Samonil, P., Chaskovskyy, O., Korol, M. & Myklush, S. (2014) A mixed severity disturbance regime in the primary Picea abies (L.) Karst. forests of the Ukrainian Carpathians. Forest Ecology and Management, 334, 144-153. Romania (Calimani) dataset: Svoboda, M., Janda, P., Bače, R., Fraver, S., Nagel, T.A., Rejzek, J., Mikoláš, M., Douda, J., Boublík, K., Šamonil, P., Čada, V., Trotsiuk, V., Teodosiu, M., Bouriaud, O., Biriş, A.I., Sýkora, O., Uzel, P., Zelenka, J., Sedlák, V. & Lehejček, J. (2014) Landscape-level variability in historical disturbance in primary Picea abies mountain forests of the Eastern Carpathians, Romania. Journal of Vegetation Science, 25, 386-401.
Publication Status	UNPUBLISHED
Publication Details	
Ownership of the dataset	Mikoláš, Martin, Miroslav Svoboda
Funding acknowledgment	The data were collected by project GACR no. 15-14840S

Data Accessibility	Regime 3: Free-access: Data are available to a wider community of users. These data can be made available on request to non-members after submitting a request to the FORESTS and CO, with no need for special approval.

Dataset 2

DATASET NAME	*LomJanPerBio*
Name	Garbarino, Matteo
e-mail address	m.garbarino@univpm.it
Affiliation and contacts	Marche Polytechnic University, Dept. D3A, Via Brecce Bianche 10, Ancona
Title of the Dataset	Shapefiles describing the distribution of *picea-abies*-beech old-growth forests in the Balkan region
Data Type	MAP
Region(s) covered	BiH, MNE
Data Completeness	PARTIAL SURVEY
Update status	2014
Object of the dataset	All the mapped forests are protected areas with their own core area and buffer zone. They can be considered old-growth forests, but probably Biogradska Gora and Perucica are the better preserved followed by Lom and lastly by Janj.
Methodological approach	The four OG forests that we mapped and surveyed were studied by using both medium resolution remote sensing (SPOT5 satellite image classification) and field-based forest structure surveys (regular grid sampling design of circular plots). Only for Lom a high resolution image (kompsat2) was used to map forest canopy gaps.
Publication Status	PUBLISHED - Data and Description
Publication Details	Motta, R., Garbarino, M., Berretti, R., Meloni, F., Nosenzo, A. & Vacchiano, G. (2014) Development of old-growth characteristics in uneven-aged forests of the Italian Alps. European Journal of Forest Research, 134, 19-31. Motta, R., Garbarino, M., Berretti, R., Bjelanovic, I., Borgogno Mondino, E., Čurović, M., Keren, S., Meloni, F. & Nosenzo, A. (2015) Structure, spatio-temporal dynamics and disturbance regime of the mixed beech–silver fir–Norway spruce old-growth forest of Biogradska Gora (Montenegro). Plant Biosystems, 149, 966-975. Garbarino, M., Borgogno Mondino, E., Lingua, E., Nagel, T.A., Dukić, V., Govedar, Z. & Motta, R. (2012) Gap disturbances and regeneration patterns in a Bosnian old-growth forest: a multispectral remote sensing and ground-based approach. Annals of Forest Science, 69, 617-625. Bottero, A., Garbarino, M., Dukic, V., Govedar, Z., Lingua, E., Nagel, T. & Motta, R. (2011) Gap-phase dynamics in the old-growth forest of Lom, Bosnia and Herzegovina. Silva Fennica, 45, 875-887. Motta, R., Berretti, R., Castagneri, D., Dukic, V., Garbarino, M., Govedar, Z., Lingua, E., Maunaga, Z. & Meloni, F. (2011) Toward a definition of the range of variability of central European mixed Fagus-Abies-Picea forests: the nearly steady-state forest of Lom (Bosnia and Herzegovina). Canadian Journal of Forest Research-Revue Canadienne De Recherche Forestiere, 41, 1871-1884. Lingua, E., Garbarino, M., Mondino, E.B. & Motta, R. (2011) Natural disturbance dynamics in an old-growth forest: from tree to landscape.

	Procedia Environmental Sciences, 7, 365-370.
Ownership of the dataset	Matteo Garbarino and Renzo Motta (University of Torino)
Funding acknowledgment	Spot Image Inc., through Planet Action Program domain "forest and deforestation," provided funding for this research by donating satellite imagery and image processing systems.
Data Accessibility	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 3

DATASET NAME	*WWF - Old Forests in Bulgaria*
Name	Tzvetan Mladenov Zlatanov
e-mail address	tmzlatanov@gmail.com
Affiliation and contacts	Forest Research Institute, Department of silviculture, 132 "St. Kliment Ohridski" Blvd., 1756 Sofia, Bulgaria
Title of the Dataset	Shapefile describing the distribution of old-growth forests in the Balkan range and Rhodopes Mountain, Bulgaria
Data Type	DATABASE
Data Coverage - Region(s) covered	The Balkan range and Rhodopes Mountain, Bulgaria
Data Completeness	PARTIAL SURVEY
Update status	2016
Object of the dataset	Project title "Mapping of old-growth forests in Bulgaria". Project promoter: WWF Bulgaria. An index for identification and evaluation of old-growth forests was used for stand selection. The criteria included: (1) Gradual reduction of the number of trees with the diameter increase; (2) Presence of certain number of large trees (depending on species); (3) Presence of standing and fallen dead trees in different wood decomposition classes (with threshold of coarse woody debris depending on species); (4) Heterogeneous spatial structure on predominating part of the forest territory with presence of natural gaps and regeneration in different development phases; (5) Lack of signs or minimal signs of management activities in the past.
Methodological approach	Elaboration of the dataset: Step 1 – Selection of potential stands based on Forest Management Plans provided by the Local Forest Enterprises; Step 2 – Further selection based on remote sensing – orthophoto pictures and topographic ancillary information; Step 3 – best candidates were inventoried on the field by assessment of DBH and spatial structure, regeneration potential, dead wood accumulation and traces of management. A systematic grid of 25 plots (100 m in size each) was set in a representative stand in each complex. The following stand structural attributes were measured and evaluated in each plot: DBH structure; growing stock (by species and total); reproduction density (by species, size and total); dead wood (by size and degrees of decomposition); gaps – number and size; canopy closure; traces of past management; topographic features. Nearly 2500 plots were established on the field.
Publication Status	PUBLISHED - Only description
Publication Details	https://naukazagorata.files.wordpress.com/2014/09/ng-1-

	2_2013_2.pdf
Ownership of the dataset	Tzvetan Mladenov Zlatanov
Funding acknowledgment	WWF Bulgaria, project No.9E0710.04, „IKEA Stage 4 and 5”
Data Accessibility	Both other custodians and the wider community can use the dataset bur only after permission of the dataset in question custodian

Dataset 4

DATASET NAME	*BULGARIA-Conifers*
Name	Panayotov Momchil
e-mail address	mp2@abv.bg
Affiliation and contacts	University of Forestry, Dendrology Department, Sofia 1756, Kliment Ohridski 10 Blvd., Bulgaria
Title of the Dataset	Shapefile with old-growth coniferous forests in Rila and Pirin National Parsk
Data Type	DATABASE
Data Coverage - Region(s) covered	Bulgaria, Pirin National Park and Rila National Park
Data Completeness	PARTIAL SURVEY
Update status	2015
Object of the dataset	Old-growth forests in the national forest database of Bulgaria (above 120 years); they were verified on orthophotos or visited on site. Small forest patches, which were adjacent to roads, were excluded despite other characteristics. The data is based on "compartment" level, which means that also younger patches of more than several hectares between older patches were excluded as not matching the first criteria of choice.
Methodological approach	The initial data collection took place during inventory works form mapping and general inventory purposes. However, for national parks in Bulgaria the level of detail was not as high as for management forests. There are occasions, when in field studies higher ages were estimated than in the inventory data. For some of the forests there was detailed work performed. Such are listed in scientific publications.
Publication Status	UNPUBLISHED
Publication Details	Panayotov, M., Tsvetanov, N., Gogushev, G., Tsavkov, E., Zlatanov, T., Anev, S., Ivanova, A., Nedelin, T., Zafirov, N., Aleksandrov, N. & Dountchev, A. (2016) *Mountain coniferous forests in Bulgaria – structure and natural dynamics*. University of Forestry, Sofia, 332 pp. Panayotov, M., Kulakowski, D., Laranjeiro Dos Santos, L. & Bebi, P. (2011) Wind disturbances shape old Norway spruce-dominated forest in Bulgaria. *Forest Ecology and Management*, **262**, 470-481. Rangelova, P. & Panayotov, M. (2013) Structure of old-growth Pinus heldreichii forests in Pirin Mountains. *Bulgarian Journal of Agricultural Science*, **19**, 273-276.
Ownership of the dataset	The original datasets belong to the Bulgarian government, Ministry of Environment and Waters.
Funding acknowledgment	Data on the structure and natural dynamics of certain forests was obtain in the framework of studies carried within the projects „*Subalpine forest development in Bulgarian Mountain Forests under*

	climate change" (IZEBZO143109) funded by the Swiss National Science Fund and the Ministry of education and science of Bulgaria."; "*Natürliche Dynamik von Lawinenschutzwäldern*" funded by the Velux Foundation in Switzerland; and „*Natural disturbances and dynamics in pristine Norway spruce (Picea abies Karst) forests*" funded by the National Science Fund of Bulgaria.
Data Accessibility	Regime 1 - Restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) and their use depends on the permission of the respective data custodian. Specific data for certain forests are however available from the contributor

Dataset 5

DATASET NAME	*CroatianOGForest*
Name	Mikac, Stjepan
e-mail address	smikac@sumfak.hr
Affiliation and contacts	University of Zagreb, Faculty of Forestry
Title of the Dataset	Croatian OG forests reserve
Data Type	MAP
Data Coverage - Region(s) covered	Croatia
Data Completeness	COMPLETE INVENTORY
Update status	2015
Object of the dataset	
Methodological approach	field research
Publication Status	UNPUBLISHED
Publication Details	
Ownership of the dataset	
Funding acknowledgment	Croatian Science Foundation under the project IP-2014-09-1834
Data Accessibility	Regime 3: Free-access: Data are available to a wider community of users. These data can be made available on request to non-members after submitting a request to the FORESTS and CO, with no need for special approval.

Dataset 6

DATASET NAME	*CZ_oldgrowth_forests*
Name	Vrska Tomas
e-mail address	tomas.vrska@vukoz.cz
Affiliation and contacts	Silva Tarouca Research Institute, dpt. Forest Ecology, Lidicka 25/27, 602 00 Brno, CZ
Title of the Dataset	
Data Type	DATABASE

Data Coverage - Region(s) covered	Czech Republic
Data Completeness	COMPLETE INVENTORY
Update status	2016
Object of the dataset	Project objectives: (i) classification of forest naturalness; (ii) to prepare the "Natural Forests Databank" as the usable system for the public, nature conservation authorities, researchers etc. We used the definitions for different degrees of naturalness incl. old-growth, primeval etc. The set of 31 criterions for evaluation was created and used for the whole country. The methodological approach is the part of Czech rule of law (Regulation No. 64/2011- Ministry of Environment)
Methodological approach	For the use in the national environmental policy and nature conservation a naturalness assessment of all the Czech forests was performed using 30 criterions (direct human impact on stand development: 17 criterions, indirect human impact on stand development: three criterions, tree species composition: seven criterions, deadwood: four criterions) (Anonymous 2011). 50 local evaluators were instructed and trained and every evaluator was responsible for one region. The forests in the protected areas were evaluated preferentially. Data from national forest databank were tested if some non-protected forest fulfill the basic criterions and if yes it was evaluated in the field. From the total forested area of 2,568 000 ha about 30 000 ha of old-growth forests were identified on 490 localities in the range of 10-1200 ha per locality. The old-growth forests were classified into three degrees of naturalness 1) 3% primeval, 2) 28% natural and 3) 69% near-natural (Adam and Vrška 2009). Actually every protected area has the management plan and al natural forests are evaluated every ten years (if some new left to spontaneous development etc.) and the Natural Forest Databank is updated every year. References: Adam, D. & Vrška, T. (2009) Important localities of old-growth forests Landscape Atlas of the Czech Republic (ed. by H.E. Al.), p. 209. Ministry of Environment and Silva Tarouca Research Institute. Anonymous (2011) Regulation No. 64/2011 on management plans, marking and register of protected areas according the Nature and Landscape Protection Act (No. 114/1992). *Statute book* pp. 645-675.
Publication Status	PUBLISHED - Data and Description
Publication Details	Data were selected from Natural Forests Databank of the Czech Republic. according to criterions in the paper and adjusted. Main part of dataset is available on-line - http://naturalforests.cz/czech-natural-forests-databank Adam, D. & Vrška, T. (2009) Important localities of old-growth forests. *Hrnčiarová et al.(eds.). Landscape Atlas of the Czech Republic. Ministry of Environment and Silva Tarouca Research Institute. 209 p*,
Ownership of the dataset	Intellectual property belongs Silva Tarouca Research Institute where Tomas Vrska and Dusan Adam are the custodians
Funding acknowledgment	Tomas Vrska was supported by an institutional subsidy (VUKOZ-IP-00027073)
Data Accessibility	Regime 1 - Restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) and their use depends on the permission of the respective data custodian.

	But data from Natural Forests Databank are free for public use: http://naturalforests.cz/czech-natural-forests-databank

Dataset 7

DATASET NAME	*Oldgrowth & long untouched forests of Denmark*
Name	Buchwald, Erik
e-mail address	ecb@nst.dk
Affiliation and contacts	Danish Nature Agency, Førstballevej 2, DK-7183 Randbøl
Title of the Dataset	Oldgrowth & long untouched forests of Denmark
Data Type	DATABASE
Data Coverage - Region(s) covered	Denmark
Data Completeness	COMPLETE INVENTORY
Update status	2016
Object of the dataset	To get a national overview of primary forests in Denmark using the terminology, criteria and definitions proposed in Buchwald 2005.
Methodological approach	Extract of Agency GIS and databases with all protected Danish forests to get the forests meeting the relevant criteria.
Publication Status	UNPUBLISHED
Publication Details	
Ownership of the dataset	Erik Buchwald
Funding acknowledgment	NA
Data Accessibility	Regime 3: Free-access: Data are available to a wider community of users. These data can be made available on request to non-members after submitting a request to the FORESTS and CO, with no need for special approval.

Dataset 8

DATASET NAME	*Old-growth-Estonia*
Name	Francesco Maria Sabatini based on data provided by Ann Kraut
e-mail address	sabatinf@hu-berlin.de
Affiliation and contacts	Humboldt-Universität zu Berlin, Department of Geography. Unter den Linden 6, 10099, Berlin. Germany
Title of the Dataset	Hemiboreal old-growth forests of Estonia
Data Type	Map
Data Coverage - Region(s) covered	Estonia
Data Completeness	PARTIAL SURVEY
Update status	2010
Object of the dataset	To improve the silvicultural targets for ecologically sustainable forestry, important structural features were quantified for the first time in a representative set of old-growth forests in hemiboreal Europe. Altogether, 23 old-growth stands of four site-type groups were compared with mature commercial stands nearby in the Estonian state forests that hold the Forest Stewardship Council (FSC)

	certificate of sustainable forestry.
Methodological approach	The survey databases of the Estonian State Forest Management Centre was used to pre-select old-growth stands based on their site type, size (≥2 ha), and the estimated age of dominant canopy trees (>120 years).
Publication Status	PUBLISHED - Only description
Publication Details	Lõhmus, A. & Kraut, A. (2010) Stand structure of hemiboreal old-growth forests: Characteristic features, variation among site types, and a comparison with FSC-certified mature stands in Estonia. Forest Ecology and Management, 260, 155-165.
Ownership of the dataset	Ann Kraut & Asko Lõhmus
Funding acknowledgment	The research was supported by the Estonian Science Foundation (grants 6457 and 7402), the Estonian Ministry of Education and Science (project SF0180012s09) and the European Union through the European Regional Development Fund (Centre of Excellence FIBIR).
Data Accessibility	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 9

DATASET NAME	*BEECH_HVF_EU*
Name	Lombardi Fabio
e-mail address	fabio.lombardi@unirc.it
Affiliation and contacts	Mediterranean University of Reggio Calabria, Department of Agraria, Contrada Melissari, Loc. Feo di Vito, 89122, Reggio Calabria, Italiy
Title of the Dataset	High Value Beech Forest in Europe
Data Type	DATABASE
Data Coverage - Region(s) covered	Large scale data (17 EU Countries)
Data Completeness	Forest extension, coordinates, Main tree species, Living and deadwood volumes, Years since last harvesting
Update status	2014
Object of the dataset	The data set was developed in a project aimed to verify if the HVF (High Value Forests) across Europe overlaps with the occurring Old-Growth Forests (see: Bastrup-Birk et al., 2014. Developing a forest naturalness indicator for Europe Concept and methodology for a high nature value (HNV) forest indicator. EEA Technical report No 13/2014, Affiliation: European Environment Agency Technical, DOI: 10.13140/2.1.1726.3684)
Methodological approach	As a first step, the beech-dominated forest area was identified considering the tree species distribution maps (JRC, 2012a; Brus et al., 2012) which report the percentage of each tree species for 1 km x 1 km pixel. The extraction of the beech forest information (pixels) was based on data from NFIs published in Annex 1 of the last State of Europe's Forests report (Barbati et al., 2011). The naturalness of pixels dominated by beech forests delineated in the previous step was assessed by multiple variables selected according to the availability of the data sets. Five indicators were selected: naturalness of tree species composition, hemeroby, growing stock volume, accessibility, connectivity

Publication Status	Report EEA
Publication Details	EEA (2014) *Developing a forest naturalness indicator for Europe. Concept and methodology for a high nature value (HNV) forest indicator*. EEA Technical report No 13/2014, Luxembourg: Publications Office of the European Union.
Ownership of the dataset	Fabio Lombardi, Gherardo Chrici
Funding acknowledgment	no
Data Accessibility	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 10

DATASET NAME	*UNESCO - Primeval Beech Forests*
Name	Francesco Maria Sabatini based on data derived from UNESCO
e-mail address	sabatinf@hu-berlin.de
Affiliation and contacts	Humboldt-Universität zu Berlin, Department of Geography. Unter den Linden 6, 10099, Berlin. Germany
Title of the Dataset	Primeval Beech Forests of the Carpathians and the Ancient Beech Forests of Germany
Data Type	MAP
Data Coverage - Region(s) covered	Slovakia, Ukraine, Germany
Data Completeness	Partial Survey
Update status	2007
Object of the dataset	The Primeval Beech Forests of the Carpathians and the Ancient Beech Forests of Germany are a serial property comprising fifteen components. They represent an outstanding example of undisturbed, complex temperate forests and exhibit the most complete and comprehensive ecological patterns and processes of pure stands of European beech across a variety of environmental conditions. They contain an invaluable genetic reservoir of beech and many species associated and dependent on these forest habitats.
Methodological approach	
Publication Status	PUBLISHED - Data and Description
Publication Details	http://whc.unesco.org/en/list/1133
Ownership of the dataset	UNESCO/World Heritage Centre
Funding acknowledgment	-
Data Accessibility	"Copyright © 1992 - 2017 UNESCO/World Heritage Centre. All rights reserved."

Dataset 11

DATASET NAME	*Extension sites of World Heritage of Primeval Beech Forests of the Carpathians and other Regions of Europe*
Name	Kirchmeir, Hanns

e-mail address	kirchmeir@e-c-o.at
Affiliation and contacts	E.C.O. Institute of Ecology, Lakesidepark B07b, 9020 Klagenfurt, Austria
Title of the Dataset	Shapefile with the proposed primeval and old growth beech forest from 11 Countries proposed for extension of the existing WH of primeval beech forests of the Carpathians and Ancient Beech forests of Germany
Data Type	MAP
Data Coverage - Region(s) covered	The dataset contains forests from Spain, Italy, Belgium, Austria, Slovenia, Croatia, Albania, Romania, Bulgaria, Ukraine and Poland
Data Completeness	Only strictly protected sites nominated for World Heritage
Update status	2016
Object of the dataset	From 2012-2014 a screening Process of the most representative primeval and old-growth beech forests was initiated by the German BfN for an final extension of the existing UNESCO World heritage of Primeval Beech forests of the Carpathians and Ancient Beech Forests of Germany. Out of the list of more than 100 potential sites, 67 polygons in 33 "Clusters" (Protected Areas) have been selected for the UNESCO WH nomination process in 2012-2016.
Methodological approach	The screening Process was initiated by a German BfN funded project from 2012-2014 with experts from all European Countries. Several workshops on expert level where held in Germany, Italy and Ukraine. The national experts added basic information on primeval or old growth beech forests (including mixed beech forests in higher altitudes). The information given for each site was name, size, protection status, max. stand age, time of protection, name of protected area (if given), altitude range. From these more than 100 potential sites the "best of the best" (large, strict protection status, representative for different European Beech forest Regions) have been selected through an iterative process. Those sites, selected for nomination as UNESCO World Heritage have been delineated as polygons be the national representatives and managers of protected areas and are collected into this dataset.
Publication Status	UNPUBLISHED
Publication Details	
Ownership of the dataset	The dataset has multiple authors.
Funding acknowledgment	Austrian federal ministry of agriculture, forestry, environment and water management
Data Accessibility	Regime 1 - Restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) and their use depends on the permission of the respective data custodian.

Dataset 12

DATASET NAME	*FinnishOGForests*
Name	Tikkanen, Olli-Pekka
e-mail address	Olli-Pekka.Tikkanen@uef.fi
Affiliation and contacts	School of Forest Sciences, University of Eastern Finland
Title of the Dataset	Shapefiles of Natural Forests of Finland
Data Type	DATABASE
Data Coverage -	Finnland

Region(s) covered	
Data Completeness	PARTIAL SURVEY
Update status	2015
Object of the dataset	Geographical delineation of areas is based on nature conservation area network of Finland, wilderness areas and those old growth forest protection program sites not included in legal protection area network of Finland. The GIS data is obtained from open data source of Finnish Environment Institute (http://www.syke.fi/en-US/Open_information). Original description of databases (metadata) is only in Finnish. Conservation area network: http://metatieto.ymparisto.fi:8080/geoportal/catalog/search/resource/details.page?uuid={2627E9FE-B657-48E1-A98D-000D4CD5CA38} Habitats conservation program sites: http://metatieto.ymparisto.fi:8080/geoportal/catalog/search/resource/details.page?uuid=%7BC305FA65-F319-4FA0-AAB8-F92AE32B6EE2%7D
Methodological approach	GIS data provided by Finnish Environment Institute contains metadata about the area of natural forests. Area of natural forests in legal conservation areas (size over 100 ha) was obtained from Natura 2000 Standard Data Form of the site (accessed by Natura 2000 viewer, http://natura2000.eea.europa.eu). Area of following Natura 2000 habitat types 9010 (western taiga), 9020 (Fennoscandian hemiboreal natural old broad-leaved deciduous forests rich in epiphytes), 9040 (Nordic subalpine forests), 9080 (deciduous swamp forests, 91D0 (bog woodland) and 91E0 (alluvial forests with Alnus glutinosa and Fraxinus excelsior) were included in metadata of this data set. Large (size over 100 ha) Old Growth Forests Protection Program sites, which are not legally protected and not included in Natura 2000 network, were assumed to be predominantly natural forest and small forest areas (10-99 ha) of Old Growth Forest Protection Programs (current legal status not checked) were assumed to be solely natural forests. This assumption is based on the metadata of the compiled data set.
Publication Status	UNPUBLISHED
Publication Details	
Ownership of the dataset	
Funding acknowledgment	
Data Accessibility	Regime 3: Free-access: Data are available to a wider community of users. These data can be made available on request to non-members after submitting a request to the FORESTS and CO, with no need for special approval.

Dataset 13

DATASET NAME	*WWF France*
Name	Vallauri, Daniel (compiled by Francesco Maria Sabatini)
e-mail address	dvallauri@wwf.fr
Affiliation and contacts	WWF, 6 rue des Fabres, F-13001 Marseille - France
Title of the Dataset	WWF - Hauts lieux de naturalité en France
Data Type	MAP

Data Coverage - Region(s) covered	France (Mediterranean Ecoregion)
Data Completeness	Partial Survey
Update status	2012
Object of the dataset	The dataset synthesizes the results of a study that aimed to characterise naturalness of Mediterranean forests. It was conducted between 2010 and 2013, in the framework of WWF-France's programme on "Ancient Forests" ("Forêts anciennes"; www.foretsanciennes.fr). The report attempted to answer a number of questions: Which method is adapted to analyse naturalness of forests in the Mediterranean ecoregion? Is this methodology fundamentally different to that applied in other regions, and if so, how? Is it possible to develop a simple, reliable and rapid assessment methodology to guide forest managers? What are the reference values for the main indicators of naturalness and human footprint in ancient forests of the ecoregion? How are these values different from those of other forests? Could this gap inspire management practices?
Methodological approach	The methodology was developed with the contribution of the programme's scientific and technical committee, as well as a long process of exchanges, syntheses and tests. It is based on multicriteria and applied at stand level. For more information, please read the guide for practical implementation (Rossi & Vallauri, 2013). Thirty-three forests were selected based on the literature and experts' knowledge, as well as using four main criteria (wherever possible): ancientness of forest cover, nativeness of the dominant tree species, maturity (old-growthness), and low human footprint (last harvesting > 60 years). In these forests (figure 1), 52 stands were fully evaluated (stand with an area of one hectare). The sample covered all main forest habitats of the 15 Mediterranean departments concerned, from meso-Mediterranean to subalpine levels, and aimed to describe the ecoregion's hotspots. In the context of Forests and Co, only those stands meeting the definition criteria of primary forest (either n6- old-growth forests, or n5-long untouched forests) were selected.
Publication Status	PUBLISHED - Data and Description
Publication Details	http://www.foretsanciennes.fr/proteger-mieux/france/ Rossi, M., Bardin, P., Cateau, E. & Vallauri, D. (2013) Forêts anciennes de Méditerrané e et des montagnes limitrophes: références pour la naturalité régionale. WWF France, Marseille, France, 144.
Ownership of the dataset	Fonds Mondial pour la Nature France (WWF France)
Funding acknowledgment	-
Data Accessibility	© 2013 – Fonds Mondial pour la Nature France Tous droits réservés.

Dataset 14

DATASET NAME	*FR-RNF*
Name	DEBAIVE Nicolas
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Affiliation and contacts	Réserves naturelles de France, La Bourdonnerie, 2 allée Pierre Lacroute - CS 67524 – 21075 DIJON cedex
Title of the Dataset	Database describing the old-growth forests within the nature reserve network in France
Data Type	DATABASE
Data Coverage - Region(s) covered	France
Data Completeness	PARTIAL SURVEY
Update status	2013
Object of the dataset	The objectives of the study were various: (i) update the existing database of OGF that were known to be protected by nature reserves (ii) identify the reasons for their evolution, (iii) highlight the role of nature reserves in the preservation of OGF and (iv) characterize these OGF on a descriptive level. The terminology we used for OGF was "Forêts à caractère naturel - FCN". A natural forest or part of a forest may be identified on the nature reserve if : (i) the last harvesting operation occurred more than 50 years ago, (ii) an important compartment of old trees and large-diameter dead wood (> 40 m3 / ha in productive forests and/or a 'deadwood volume'/'live wood volume' ratio> 10%) is found in this forest, (iii) the stands are characterized by a high forest structure (i.e. : not a coppice forest) and (iv) the tree cover is predominantly represented by indigenous species (of local genetic strains).
Methodological approach	Data were collected using a questionnaire. A forest could be identified if the 4 criteria mentioned above were filled in and validated. Note that some of the criteria could have been filled using estimated data (versus calculated data).
Publication Status	UNPUBLISHED
Publication Details	
Ownership of the dataset	Réserves naturelles de France
Funding acknowledgment	
Data Accessibility	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 15

DATASET NAME	*STRICD*
Name	Meyer Peter
e-mail address	Peter.Meyer@w-fva.de
Affiliation and contacts	Northwest German Forest Research Institute
Title of the Dataset	Old strict forest reserves Germany
Data Type	DATABASE
Data Coverage - Region(s) covered	Germany
Data Completeness	PARTIAL SURVEY
Update status	2016
Object of the dataset	The objective was to identify all forest stands in Germany which meet the criteria for long untouched forest (n5, s. Buchwald 2005: set

	aside from active (forestry) management since at least 60 years).
Methodological approach	All representatives of forestry research organizations, which are members of the working group "Naturwälder", were asked to supply the required information including coordinates of the forest stands.
Publication Status	UNPUBLISHED
Publication Details	
Ownership of the dataset	The dataset belongs to several third parties, i.e. the responsible institutions of the German countries. These are: Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg, Bayerische Landesanstalt für Wald und Forstwirtschaft, Ministerium für Infrastruktur und Landwirtschaft des Landes Brandenburg, Nordwestdeutsche Forstliche Versuchsanstalt, Landesforst Mecklenburg-Vorpommern, BT Forstplanung, Versuchswesen, Informationssysteme, Landesbetrieb Wald und Holz Nordrhein-Westfalen, Zentralstelle der Forstwirtschaft, Forschungsanstalt für Waldökologie und Forstwirtschaft, Rheinland-Pfalz
Funding acknowledgment	
Data Accessibility	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 16

DATASET NAME	*GREEK DATASET*
Name	Grigoriadis Nikolaos
e-mail address	grig_nick@fri.gr
Affiliation and contacts	Forest Research Institute Thessaloniki Vassilika 57006 Greece
Title of the Dataset	Oldgrowth Forests In North Greece
Data Type	DATABASE
Data Coverage - Region(s) covered	Dataset of forest service in region of Macedonia (west, central & east)
Data Completeness	PARTIAL SURVEY
Update status	2012
Object of the dataset	The main objective of the sub-project is to select data of old growth forests in Greece and provide sufficient support to FORESTS and CO project in accessing the data to include it in the map of Europe's primary forests. The main criteria for selection of the dataset were: location set aside area / not managed forests and age stand.
Methodological approach	To construct the dataset, different sources were used; mainly the forest plans of the local Forest Services, databases of the protected sites by the Local Management Authorities and own data (Forest Research Institute of Thessaloniki).
Publication Status	UNPUBLISHED
Publication Details	N/A
Ownership of the dataset	Grigoriadis Nikolaos, Fotiadis Georgios
Funding acknowledgment	
Data Accessibility	Regime 1 - Restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) and their use depends on the permission of the respective data custodian.

Dataset 17

DATASET NAME	*Primary forest stands of Hungary*
Name	Horváth, Ferenc
e-mail address	horvath.ferenc@okologia.mta.hu
Affiliation and contacts	MTA Centre for Ecological Research, Institute of Ecology and Botany, Alkotmány u. 2-4, 2163 Vácrátót, Hungary
Title of the Dataset	Best known old-growth and long untouched forest stands of the strict forest reserves of Hungary
Data Type	MAP
Data Coverage - Region(s) covered	Hungary
Data Completeness	PARTIAL SURVEY
Update status	2016
Object of the dataset	1. The objectives are to select and delineate well-known old-growth and long untouched stands of strictly protected, unmanaged core areas of Strict Forest Reserves of Hungary. 2. The criteria of Buchwald (2005) was applied.
Methodological approach	Strict Forest Reserves of Hungary were selected and evaluated by an Interministerial National Committee for Forest Reserves based on extensive surveys of candidate sites in the 90ies. The proposed forest reserves based on the 2nd national extensive survey in 1998/1999 were evaluated and classified (Horváth and Bölöni 2002) according to the forest research strategy (Standovár 2002) in accordance with the main recommendations of the COST Action E4 - Forest Reserves Research Network (Parviainen et al. 2000). Than a re-evaluation and re-classification of 'old-growth' characteristics of core areas and stands was performed based on all the available reports of the Forest Reserve Programme Archive. The delineation of strictly protected designated core areas were considered but modified in the case of Kékes, Vár-hegy, Őserdő, Szalafő and Vétyem to narrow the shapes that appropriately meet the criteria for old-growth and/or long untouched stands. World Imagery (ESRI) was also applied for visual checking of boundaries.
Publication Status	UNPUBLISHED
Publication Details	Evaluation was based on the following references and websites: Manuscripts and Documents in ER Archive, http://www.erdorezervatum.hu/en/ERA_Documents Horváth, F., Bidló, A., Heil, B., Király, G., Kovács, G., Mányoki, G., Mázsa, K., Tanács, E., Veperdi, G. & Bölöni, J. (2012) Abandonment status and long-term monitoring of strict forest reserves in the Pannonian biogeographical region. *Plant Biosystems - An International Journal Dealing with all Aspects of Plant Biology*, **146**, 189-200. Horváth, F. & Bölöni, J. (2002) Az erdőrezervátumok kutatásszempontú besorolása és rövid jellemzése 1999-ben (Classification and brief description of forest reserves in 1999 from the viewpoint of research perspective). *A hazai erdőrezervátum-kutatás célja, stratégiája és módszerei (Aims, strategy and methods of forest reserve research in Hungary)* (ed. by F. Horváth and B. A), pp. 276-287, TermészetBÚVÁR Kiadó, Budapest. Standovár, T. (2002) Az erdőrezervátum-kutatás stratégiája és

	módszertana (Strategy and methodology of forest reserve research). *A hazai erdőrezervátum-kutatás célja, stratégiája és módszerei (Aims, strategy and methods of forest reserve research in Hungary)* (ed. by F. Horváth and A. Borhidi), pp. 88-99, TermészetBÚVÁR Kiadó, Budapest. Juhdöglő-völgy Forest Reserve (ER-07), http://www.erdorezervatum.hu/en/Juhdoglo-volgy_FR Kunpeszéri Tilos-erdő Forest Reserve (ER-15), http://www.erdorezervatum.hu/en/Kunpeszeri_Tilos-erdo_FR Vétyem Forest Reserve (ER-36), http://www.erdorezervatum.hu/en/Vetyem_FR Szalafő Forest Reserve (ER-53), http://www.erdorezervatum.hu/en/Szalafo_FR Kékes Forest Reserve (ER-56), http://www.erdorezervatum.hu/en/Kekes_FR Vár-hegy Forest Reserve (ER-59), http://www.erdorezervatum.hu/en/Var-hegy_FR Őserdő Forest Reserve (ER-60), http://www.erdorezervatum.hu/en/Oserdo_FR Alsó-hegy Forest Reserve (ER-68), http://www.erdorezervatum.hu/en/Also-hegy_FR
Ownership of the dataset	Horváth, Ferenc
Funding acknowledgment	
Data Accessibility	Regime 1 - Restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) and their use depends on the permission of the respective data custodian.

Dataset 18

DATASET NAME	*ItalyNP*
Name	Burrascano, Sabina
e-mail address	sabina.burrascano@uniroma1.it
Affiliation and contacts	Sapienza University of Rome, Dept. of Environmental Biology, P.le Aldo Moro 5 00185 Rome Italy, +390649912845
Title of the Dataset	ForesteVetuste
Data Type	MAP
Region(s) covered	Italian National Parks (23 Parks as in 2008)
Data Completeness	COMPLETE INVENTORY
Update status	2008
Object of the dataset	The definition of old-growth developed during the project is: "Forests in which human disturbance is absent or negligible, and in which natural dynamics create a mosaic of all the forest regeneration phases, including the senescing one. Such a phase is characterized by large old trees, deadwood (snags logs and coarse woody debris) and a vascular plant species composition that is consistent with the

	biogeographical context and includes highly specialized taxa related to the small-scale disturbance and the microhabitats resulting from structural heterogeneity"
Methodological approach	"The dataset was based on a questionnaire sent to the staff of National Parks and of State Forestry Corps aimed at gathering information on the structure and management history of stands potentially displaying attributes associated to old-growth forests. Among the stands that were identified by the questionnaires a selection was performed based on field surveys carried out by forest scientists and botanists. Stands were divided into three different classes of old-growth based on: i) diameter distribution of living trees, ii) amount of deadwood (volume), iii) quality of deadwood (decomposition classes). From 0 to 4 points were assigned to each stand. The score depended on how closely the living structure fitted the diameter correspondence curves usually associated to old-growth stands, i.e. the reverse J-shape curve, which attests to the presence of numerous young trees and a decreasing number of trees with a larger DBH, and the rotated-sigmoid curve, which is the semilog graph of the tree number per DBH class (see Lorimer & Frelich 1984). Another point was assigned on the basis of the number of large trees (DBH > 40 cm) per hectare. Every site with more than 70 large trees per hectare gained a point. This threshold was defined following Nilsson et al. (2002). A further four points were assigned for the amount and the quality of deadwood, two points being assigned for amount of deadwood per hectare and two points for the quality, the latter being determined on the basis of the number of decomposition classes and maximum class observed. The stands scores thus ranged from a minimum of 0 to a maximum of 9 points. Each stand was then assigned to one of three old-growth levels: low, medium or high.
Publication Status	PUBLISHED - Only description
Publication Details	Blasi, C., Burrascano, S., Maturani, A. & Sabatini, F.M. (2010) *Old-growth forests in Italy.* Palombi Editori, Rome, Italy.
Ownership of the dataset	The dataset belongs to the Ministry for the Environment, Land and Sea Protection and to the Interuniversity Research Center “Biodiversity, Plant Sociology and Landscape Ecology” Sapienza University of Rome. Sabina Burrascano represents the latter organization as a custodian.
Funding acknowledgment	"Le foreste vetuste nei Parchi Nazionali d'Italia. Caratterizzazione floristica, vegetazionale, strutturale e linee guida per la conservazione e la gestione", Ministry for the Environment, Land and Sea Protection
Data Accessibility	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 19

DATASET NAME	*Database of natural forests in Lithuania*
Name	Mozgeris Gintautas
e-mail address	gintautas.mozgeris@asu.lt
Affiliation and contacts	Institute of Forest Management and Wood Science Aleksandras Stulginskis University Studentų 11, LT-53361 Akademija, Kaunas reg., Lithuania

Title of the Dataset	File geodatabase describing the location and key attributes of natural forests in Lithuania
Data Type	MAP
Data Coverage - Region(s) covered	Lithuania
Data Completeness	COMPLETE INVENTORY
Update status	2016
Object of the dataset	The database was compiled following “Technical guidelines for Contributing Data to WP1” (ver. 1.0), thus, the objectives, definitions and criteria follow the ones used in the guidelines. However, the definition of the level of naturalness may differ: i) as a n7 we identified large areas with old growth stands with no intervention more than 60 years; ii) n6 we used for areas which are formally established to protect “old growth forest”; iii) n5 – forests with long period without intervention. Even some areas were legally established several decades or less ago, but practically they were out of forestry activities since 1950-1960s.
Methodological approach	The database was compiled in 2016 and is based on geographic information available from Lithuanian state forest cadaster. The state forest cadaster is based on data from stand-wise forest inventories. The state forest cadaster is updated according to occurring changes, but at least once in 10-year period. Permanent monitoring of forest stands is supposed to be initiated in the nearest future. First of all, the borders of all forest stands with potential no intervention status were selected in the state forest cadaster database and copied to the ArcGIS (ver. 10.3) file geodatabase. State forest cadaster contains some information on protection status for all forest stands in Lithuania. Forest stand polygons belonging to the same tract were merged and their attribute structure was created following the technical guidelines. Then two experts (prof. A.Augustaitis and prof.V.Marozas from Aleksandras Stulginskis university) with experience in forest ecology were consulted and all polygons one-by-one were checked whether they could fit at least some level of naturalness. Next, some areas were removed where no intervention is legally prescribed due to some other reasons, like the protection of historical sites, recreational objects, etc. Level of naturalness was assigned to each polygon in the database. Two additional areas in Curronian Spit with pine stands 150-200 years old and no intervention due to specific location but without formal requirement for no-management were included based on recommendations of both experts. Then stand level attributes were summarized to estimate the prevailing tree species. Within the database they appear in a decreasing order according to their coverage. As the 3rd species we added some specific tree species for which the area could be established – e.g. we have one long untouched forest with Quercus petrea etc. even there could be some other more abundant tree species. As majority of areas are under administration of some protected areas, the corresponding websites, legal acts and other documents were studied to provide descriptions required.
Publication Status	UNPUBLISHED
Publication Details	
Ownership of the dataset	Information available from Lithuanian State forest cadaster was used to get the boundaries and attributes of forest stands. This information is used on the base of license agreement between Aleksandras Stulginskis university and State Forest Service.
Funding acknowledgment	

Data Accessibility	Regime 3: Free-access: Data are available to a wider community of users. These data can be made available on request to non-members after submitting a request to the FORESTS and CO, with no need for special approval.

Dataset 20

DATASET NAME	*PriMaFor*
Name	Simovski, Bojan
e-mail address	bsimovski@sf.ukim.edu.mk
Affiliation and contacts	Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Dept. of Botany and Dendrology, P. O. Box 235, MK-1000 Skopje, Republic of Macedonia
Title of the Dataset	Shapefile of distribution, area and species composition of certain forest communities (primary forests) in the Mavrovo National Park, Republic of Macedonia
Data Type	DATABASE
Data Coverage - Region(s) covered	Mavrovo National Park, Republic of Macedonia
Data Completeness	Almost complete inventory (some remote and/or poorly accessible areas missing)
Update status	2014
Object of the dataset	1. To gather relevant data and map certain forest communities with virgin forest characteristics in Macedonia - in particular protected areas (NP Mavrovo); 2. The custodian used the criteria proposed by the FOREST and CO team - the definition framework defined in Buchwald et al. (2005). In addition, the custodian's research is also based on 'forests with virgin forest characteristics' (Simovski, B., 2015: Natural succession processes /stand dynamics/ of the forests in the National Park Mavrovo, PhD thesis, Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje /in Macedonian/).
Methodological approach	Before the start of field research, appropriate existing literature was used, relating to previous research related to the Mavrovo National Park and it is listed in the References section. For conducting field surveys were used topographic maps M = 1:25000 and other printed maps, satellite and aero-photo imagery (LANDSAT), GPS measurements and more, in the most part provided by forestry-geomatic laboratory techniques in QGIS (GIS Lab) at Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje. Each field activity was followed by digital photography; in fact all the dendro-phytosociological data are recorded with appropriate photographs. Finally, these forest communities' maps were digitized, i.e. geo-referenced in the suitable GIS software.
Publication Status	There is no publication of the data concerning these type of forest communities (as far as custodian concern, only in PhD and MSc thesis of the custodian, mentioned in reports and briefly in two original scientific articles)
Publication Details	Reference list: Simovski, B. (2015) *Natural succession processes (stand dynamics) of the forests in the National Park Mavrovo. PhD thesis*. Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje. (in Macedonian) Simovski, B. & Acevski, J. (2012) The Fir as a Destructor of the Forest Communities in the Republic of Macedonia. *Kastamonu University*

	Journal of Forestry Faculty, **12**, 105-113. Acevski, J. & Simovski, B. (2012) Forest associations of the National Park Mavrovo in the Republic of Macedonia. *Proceedings of the International Conference Integrated Management of Environmental Resources-Suceava, November*, pp. 17-27. Acevski, J. & Simovski, B. (2011) Study on revaluation of natural values of the protected area Mavrovo. *Oxfam Italia (Project: Protection of the environment, economic development and promotion of sustainable eco-tourism in the National Park Mavrovo, in Macedonian)*, 249-264. Simovski, B. (2011) *Dendrofloristic characteristics of the National Park Mavrovo. MSc thesis*. Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje. (in Macedonian)
Ownership of the dataset	Asst. Prof. Dr. Bojan Simovski, Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Dept. of Botany and Dendrology (collaborators: Prof. Dr. Jane Acevski, Asst. Prof. Dr. Ivan Minchev)
Funding acknowledgment	Some research was previously supported as a part of the project by Unità e Cooperazione per lo Sviluppo dei Popoli UCODEP (Oxfam Italia): Protection of the environment, economic development and promotion of sustainable eco-tourism in the National Park Mavrovo (2008-2011, N. AID: 8740/Ucodep/MCD)
Data Accessibility	Regime 3: Free-access: Data are available to a wider community of users. These data can be made available on request to non-members after submitting a request to the FORESTS and CO, with no need for special approval.

Dataset 21

DATASET NAME	*Norwegian dataset*
Name	Midteng, Rein
e-mail address	rein.midteng@asplanviak.no
Affiliation and contacts	Asplan Viak AS, Analyse og utredning, Postboks 24, N-1300 Sandvika
Title of the Dataset	WWF-priority_unike_skoger_final.shp
Data Type	MAP
Data Coverage - Region(s) covered	Norway
Data Completeness	PARTIAL SURVEY
Update status	2016
Object of the dataset	1. The dataset consist of the 50 most unique not-protected (by 2015) old-growth forests. 2. Old-growth forests. Not necessary primeval forests, but all natural and biological valuable forests.
Methodological approach	All forests are surveyed in the field by biologists and reports of the areas exist in Norwegian
Publication Status	PUBLISHED - Data and Description
Publication Details	Skogkur 2020. Redningsplan for Norges unike skoger
Ownership of the dataset	Rein Midteng and WWF Norway
Funding acknowledgment	
Data Accessibility	Regime 3: Free-access: Data are available to a wider community of users. These data can be made available on request to non-members

	after submitting a request to the FORESTS and CO, with no need for special approval.

Dataset 22

DATASET NAME	OGPOL
Name	Szwagrzyk, Jerzy
e-mail address	rlszwagr@cyf-kr.edu.pl
Affiliation and contacts	Institute of Forest Ecology and Silviculture, University of Agriculture, Krakow, al. 29 listopada 46, 31-425 Krakow
Title of the Dataset	Database of old-growth forests of Poland
Data Type	DATABASE
Data Coverage - Region(s) covered	Poland
Data Completeness	COMPLETE INVENTORY
Update status	2000
Object of the dataset	The database was compiled first as a part of the project ERBC - Carpathian Ecoregion Initiative - Phase II, Biodiversity Working Group, Sector: Virgin Forests Sector Coordinator: Dr. Ioan V. Abrudan. The definition used within the project for virgin forest: forest which shows natural forest dynamics, such as natural tree composition, occurrence of dead wood, a natural (un-even) age structure and natural regeneration processes. Furthermore, it comprises an area large enough to maintain its natural characteristics and shows no signs of any human intervention to affect natural processes and dynamics. In Case of Poland, all the old-growth stands are located either in forest reserves, or in national parks
Methodological approach	The dataset was compiled using data from the literature (including unpublished manuscripts) as well as some data collected by the author and his co-workers
Publication Status	UNPUBLISHED
Publication Details	References: Breymeyer, A., Denisiuk, Z., Dmowski, K., Dobrowolski, K., Goczoł-Gontarek, M., Gontarek, M., Jędraszko-Dąbrowska, D., Kot, M., Krzan, Z., Okołów, C., Parusel, J., Piotrowska, H., Siarzewski, W., Skawiński, P., Stoyko, S., Terry, J. & Wojterski, T. (1994) Biosphere Reserves in Poland. In: (ed. P.N.M. Committee), Warszawa. Czubiński, Z., Gawłowska, J. & Zabierowski, K. (1977) Nature reserves in Poland (in Polish, with English summary). *Studia Naturae*, **27**, 528 pp. Dziewolski, J. (1987) The succession of the selected tree stands in the Babia Góra National Park (in Polish, with English summary). *Ochrona Przyrody*, **45**, 76-129. Dziewolski, J. (1990) Changes in the structure of the forest stands of the “Nad Kotelniczym Potokiem” nature reserve in the Beskid Sądecki Mts. in the years 1969-1982 (in Polish, with English summary). *Ochrona Przyrody*, **47**, 189-200. Dziewolski, J. (1991) Direction of changes in forest stands in national

parks of Polish Carpathians under strict and partial protection (in Polish, with English summary). *Prądnik, Prace Muz. Szafera*, **4**, 9-26.

Holeksa, J. (1986) The sylvan complex at the western border of the Polish Carpathian Mts. deserves protection (in Polish, with English summary). *Chrońmy Przyrodę Ojczystą*, **47**, 5-16.

Holeksa, J., Karczmarski, J., Wilczek, Z. & Ciapała, S. (1996) The Romanka reserve in the Beskid Żywiecki Mountains as an example of inappropriate forest ecosystem protection (in Polish, with English summary). *Ochrona Przyrody*, **53**, 19-35.

Jaworski, A. (1997) Carpathian forests of primeval character and their importance in shaping the pro-ecological model of forest management in mountains. Sylwan, 141, 33-49.

Jaworski, A. & Karczmarski, J. (1990) Constitution and structure of lower mountain forest zone stands of primeval character in the National Park of Mt. Babia Góra. *Acta Agraria et Silvestria. Series Silvestris*, **29**, 49-64.

Jaworski, A. & Karczmarski, J. (1991) Structure and dynamics of virgin-type stands in the Pieniny National Park (Exemplified by 4 experimental plots) (in Polish, with English summary). *Zeszyty Naukowe AR Kraków. Seria Leśnictwo*, **20**, 45-83.

Jaworski, A., Karczmarski, J. & Skrzyszewski, J. (1993) Constitution and structure of common linden forest in the Obrożyska reserve *Acta Agraria et Silvestria. Series Silvestris*, **31**, 57-79.

Jaworski, A., Karczmarski, J. & Skrzyszewski, J. (1994) Dynamics and structure of forest stands in the reserve „Łabowiec”. *Acta Agraria et Silvestria. Series Silvestris*, **32**, 3-26.

Jaworski, A., Kołodziej, Z. & Skoczeń, W. (2000) Composition and structure of upper-mountain spruce forests on the Pilsko crest (in Polish, with English summary). *Sylwan*, **144**, 35-53.

Jaworski, A., Pach, M. & Skrzyszewski, J. (1995) Structure of stands with beech and sycamore maple in the Moczarne forest complex and below Mount Rabia Skała (Bieszczady Mts). *Acta Agraria et Silvestria. Series Silvestris*, **33**, 39-73.

Jaworski, A. & Skrzyszewski, J. (1995) Structure and dynamics of stands of virgin character in the lower montane forest zone of the Łopuszna reserve. *Acta Agraria et Silvestria. Series Silvestris*, **33**, 3-37.

Jaworski, A., Skrzyszewski, J., Świątkowski, W. & Karczmarski, J. (1991) Structure of lower montane zone virgin type stands in selected areas of the Bieszczady Mts.) (in Polish, with English summary). *Zeszyty Naukowe AR Kraków. Seria Leśnictwo*, **20**, 17-43.

Karczmarski, J. (1995) Structure of spruce stands of virgin character in the upper montane forest zone in Tatra valleys of Rybi Potok, Pańszczyca and Gąsienicowa. *Acta Agraria et Silvestria. Series Silvestris*, **33**, 167-198.

Michalik, S. (1967) The „Turbacz” nature reserve in the Gorce Mts.

(Polish Western Carpathians) (in Polish, with English summary). *Studia Naturae*, **24**, 93 pp..

Michalik, S. & Kurzyński, J. (1990) The vegetation of the Puszcza Bieszczadzka nad Sanem (Bieszczady Primeval Forest on the San River) Forest Reserve (in Polish, with English summary). *Ochrona Przyrody*, **47**, 93-109.

Myczkowski, S. (1967) A project for the network of strict nature reserves in the Tatra National Park (in Polish, with English summary). *Ochrona Przyrody*, **32**, 41-88.

Przybylska, K. & Kucharzyk, S. (1999) Species composition and structure of forests of the Bieszczady National Park (in Polish, with English summary). *Monografie Bieszczadzkie*, **6**, 159 pp.

Staszkiewicz, J. (2000) Nature reserves (in Polish). *The Nature of the Popradzki Landscape Park* (ed. by J. Staszkiewicz), pp. 273-295. Popradzki Park Krajobrazowy, Stary Sącz.

Szwagrzyk, J., Szewczyk, J. & Bodziarczyk, J. (1995) Structure of forest stand in the Zarnowka reserve of the Babia Gora National Park. *Folia Forestalia Polonica. Series A. Forestry*, **37**, 111-123.

Szwagrzyk, J., Szewczyk, J., Hutka, D. & Zielonka, T. (1996) The age structure of the natural spruce forest in the Tatra National Park (in Polish, with English summary). *Przyroda Tatrzańskiego Parku Narodowego a Człowiek) PTPNoZ i TPN,* (ed. by A. Kownacki), pp. 60-62, Kraków, Zakopane.

Ownership of the dataset	Jerzy Szwagrzyk
Funding acknowledgment	ERBC - Carpathian Ecoregion Initiative - Phase II Biodiversity Working Group Sector: Virgin Forests Sector Coordinator: Dr. Ioan V. Abrudan. The project was funded by WWF.
Data Accessibility	Regime 3: Free-access: Data are available to a wider community of users. These data can be made available on request to non-members after submitting a request to the FORESTS and CO, with no need for special approval.

Dataset 23

DATASET NAME	*OldForestsPT*
Name	Duarte, Inês
e-mail address	inesmarquesduarte@gmail.com
Affiliation and contacts	Centre for Applied Ecology "Professor Baeta Neves" (CEABN), InBio, School of Agriculture, University of Lisbon, Tapada da Ajuda 1349-017, Lisbon, Portugal.
Title of the Dataset	Shapefile describing the distribution of old growth forests in Mainland Portugal
Data Type	DATABASE
Data Coverage - Region(s) covered	Mainland Portugal
Data Completeness	PARTIAL SURVEY, it was possible to collect the present old growth forest areas, but we believe that are more old forests existing in

	Portugal
Update status	2016
Object of the dataset	Portugal, as all mediterranean countries, has a long history of land use changes due to important climatic variations, including glaciation periods, and to increased human influence through - firewood collection, grazing with domestic animals, fire, and the development of agriculture since Neolithic times (Pasquale et al., 2004). Changes have been accelerating in the last century due to increased land abandonment related to population migration to urban areas. Long untouched forests still remain in Mainland Portugal, but in residual specific spots, like inaccessible areas. The objective of this project was to identify, as much as possible, areas of autochthonous long-untouched forest in Mainland Portugal. We used the terminology and references provided by the coordinator of the Forest &CO Project. We identified autochthonous forests which corresponded to the naturalness level classification of Buchwald (2005) n5 - Long Untouched Forest; n6 - Old-growth Forest. References Pasquale, G.D., Martino, P.D. & Mazzoleni, S. (2004) Forest history in the Mediterranean region. *Recent dynamics of the Mediterranean vegetation and landscape*, 13-20.
Methodological approach	After analyzing briefly the National Forest Inventory, where it was possible to identity the oldest forests, we noted it was not possible to achieve the objective without the information of management. We created a questionnaire and passed it on to National forest services, Forest owners associations and recognized botanists in the whole of Portugal. The questionnaire collected information about forest areas with more than 60/80 years: Dominant species; location (point or area); mean age of the stand; management and additional information. This information was also complemented with interviews to experts in botany with long experience in field. We joint also two areas, known as protected by National legislation as primeval reserves. From a joint effort it was possible to collect information from National Forest Services, Forest Owners and Experts, since detailed descriptions with (observation in situ), GoogleEarth® delimitation; to simple points where the oldest forests with higher naturalness levels are present. The classification of naturalness level by Buchwald (2005) was applied by our team for each case, following the descriptions received.
Publication Status	UNPUBLISHED
Publication Details	
Ownership of the dataset	In the data collection, we informed the collaborators about the objectives of FOREST&CO project, requesting contributions for a European database of the primeval forest. All the collected data were provided without any request for restrict access. CEABN, Centro de Ecologia Aplicada Prof. Baeta Neves, will be the keeper of the data, providing it to the use in the project Forest & Co.
Funding acknowledgment	
Data Accessibility	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 24

DATASET NAME	*Laurissilva_PT_forest*
Name	Nunes, Leónia
e-mail address	lnunes@isa.ulisboa.pt
Affiliation and contacts	Centre for Applied Ecology "Professor Baeta Neves" (CEABN), InBio, School of Agriculture, University of Lisbon, Tapada da Ajuda 1349-017, Lisbon, Portugal
Title of the Dataset	Shapefile describing the distribution of Laurissilva frontier forest in the Portuguese Macaronesian region.
Data Type	DATABASE
Data Coverage - Region(s) covered	Madeira Island, Macaronesian Region
Data Completeness	COMPLETE INVENTORY
Update status	2015
Object of the dataset	Laurissilva subtropical forests represents a pristine forest that constitutes the world's largest remaining area of the Tertiary forests that covered most of the south of Europe and the North of Africa (Capelo, 2004; Menezes et al., 2007). This project aims to identify the Laurissilva primary forest in Madeira Island, within the Macaronesian region. The terminology used to classify this type of forest follows the one given by the coordinator of the project FOREST & CO, taking into account the Naturalness level according to Buchwald (2005). This forest was classified as n8 - Frontier Forest. Aguiar, C., Capelo, J., Costa, J.C., Fontinha, S., Espírito-Santo, D., Jardim, R., Lousã, M., Rivas-Martínez, S., Mesquita, S. & Sequeira, M. (2004) A paisagem vegetal da Ilha da Madeira. *Quercetea*, **6**, 3-200. Menezes, D., Freitas, I., Gouveia, L., Mateus, G., Domingues, M., Oliveira, P. & Fontinha, S. (2004) A Floresta Laurissilva da Madeira, Património Mundial. *Parque Natural da Madeira. Madeira*, 30. Buchwald, E. (2005) A hierarchical terminology for more or less natural forests in relation to sustainable management and biodiversity conservation. *Proceedings: Third expert meeting on harmonizing forest-related definitions for use by various stakeholders* Food and Agriculture Organization of the United Nations, Rome, 17-19 January 2005.
Methodological approach	The first steps were to identify the Laurissilva forests in Macaronesia region and analyse those that belongs to Portugal. This type of forest occurs in Portugal only in the biogeographic region of Macaronesia located in archipelagos of Madeira and Azores. The management of these forests are under the ownership of the Regional Forest Services. The Forest Services of Madeira provided us information to identify the primary forests in the Laurissilva based on data from the Madeira Forest Inventory, IFRAM2 – 2015 (DRFCN, 2015). The Naturalness level of this forest was identified according to the classification of Buchwald (2005), taking into account the information we have from the experts of this forest. The data were organized in a database and in a map with the structural attributes X and Y, based in the original a raster format provided by the Forest services.

	DRFCN (2015). IFRAM2 - 2º Inventário Florestal da Regiao Autónoma da Madeira. Secretaria Regional do Ambiente e dos Recursos Naturais, Funchal. 114 p.
Publication Status	There is a published report about the Madeira Forest Inventory, IFRAM2 – 2015 (DRFCN, 2015) with information related to the fieldwork and the main evaluation results of forest areas, like volume and biomass. The information regarding the Laurissilva forest is also in this report but has only the main results of the forest data. The raw data is not published nor even publicly available and the Regional Forest Services of Madeira have the ownership of the raw data. Reference: DRFCN (2015). IFRAM2 - 2º Inventário Florestal da Regiao Autónoma da Madeira. Secretaria Regional do Ambiente e dos Recursos Naturais, Funchal. 114 p.
Publication Details	DRFCN (2015). IFRAM2 - 2º Inventário Florestal da Regiao Autónoma da Madeira. Secretaria Regional do Ambiente e dos Recursos Naturais, Funchal. 114 p.
Ownership of the dataset	The Regional Forest Services of Madeira made available to CEABN/InBIO the Madeira Forest Inventory data (IFRAM2 – 2015) to be used in the project FOREST & CO in order to contribute to these European primary forests database and to develop a map of known primary forest. The CEABN/InBIO can use the data in the context of this project.
Funding acknowledgment	None.
Data Accessibility	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 25

DATASET NAME	
Name	Radu Nicolae Melu
e-mail address	rmelu@wwfdcp.ro
Affiliation and contacts	WWF DCP RO Organization, forest department, Str. Dumitru Zosima, no.39 Bucuresti
Title of the Dataset	Shapefile describing the old growth forests identified until now in Romania
Data Type	DATABASE
Data Coverage - Region(s) covered	Country -Romania (Brasov, Covasna, Sibiu, Caras-Severin, Gorj, Meheninti Maramures Counties)
Data Completeness	PARTIAL SURVEY
Update status	2016
Object of the dataset	The forest objectives - Support Responsible Forest Management for a Sustainable Development. The criteria used is here: http://www.carpathianconvention.org/tl_files/carpathiancon/Downloads/03%20Meetings%20and%20Events/COP/2014_COP4_Mikulov/Follow%20Up/DOC13_Criteria_Indicators_virginforests_FINAL_26SEP.pdf These are the criteria adopted by the Carpathian Convention and in the same form, is adopted in Minister Order 3397/2012 from Romania
Methodological approach	Forests subject to identification were identified in a previous project in 2005 (http://www.mmediu.ro/app/webroot/uploads/files/2015-12-22_Virgin_forest_Romania_Summary.PDF) as virgin forests. Now their condition was largely degraded and should be evaluated according to

	criteria of the Carpathian Convention and Romanian legislation. The identification process is divided into 2 steps: 1 GIS identification – analysis of data from forest administration and satellite images (accessibilities, the age of the forests etc.). In this phase all the forest which do not meet the criteria were eliminated. 2 Field identification - where the forest specialists evaluate the forest qualified in first stage in field. The forests which meet the criteria in the field will be promoted, as virgin / quasi-virgin forests.
Publication Status	Only geographical data
Publication Details	http://www.lemncontrolat.ro/ro/prima-pagina/
Ownership of the dataset	Database belongs to the association WWF
Funding acknowledgment	-
Data Accessibility	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 26

DATASET NAME	*Prales Database*
Name	Vysoky, Juraj (compiled by Francesco Maria Sabatini)
e-mail address	info@pralesy.sk
Affiliation and contacts	PRALES, Komenskeho 21, 974 01 Banska Bystrica, Slovakia
Title of the Dataset	Old Growth Forests in Slovakia
Data Type	MAP
Data Coverage - Region(s) covered	Slovakia
Data Completeness	Complete Inventory
Update status	2015
Object of the dataset	Data are the result of a comprehensive inventory focused on the identification of primary forests (n10-n6 interval in Buchwald's scheme) in Slovakia. Inventory was done under 2 projects. First project "Protection of primary forest of Slovakia" was done during 2009-2010 and was focused on identification of primary forests over 25 ha. The second project "Identifying and protecting of primary forests in Slovakia" was done during 2013-2015 and was focused on identification of primary forest remnants (5-25 ha) and on updating of data from first project.
Methodological approach	Field mapping was preceded by a careful selection of the areas with expected occurrence of the old growth forests. This selection was based on database of the forests stands of the National Forestry Centre and a survey of the ortophotomaps. Finally, 324 localities with area over 53 000 ha was selected for the field mapping. Based on the field mapping of each site were identified borders of the old growth forests and filled in forms of data for each locality. These data were processed in the GIS and the map together with the database of old growth forests in Slovakia was created.
Publication Status	PUBLISHED - Data and Description

Publication Details	http://en.pralesy.sk/index.php
Ownership of the dataset	PRALES, Komenskeho 21, 974 01 Banska Bystrica, Slovakia
Funding acknowledgment	Project was funded by EEA Financial Mechanism, Norway Financial Mechanism and the State budget of the Slovak republic through Ekopolis Foundation (www.ekopolis.sk). Project was also supported by WWF.
Data Accessibility	Regime 1 - Restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) and their use depends on the permission of the respective data custodian.

Dataset 27

DATASET NAME	*Grafični prikaz gozdnih rezervatov*
Name	Francesco Maria Sabatini (based on data provided by Rok Pisek)
e-mail address	sabatinf@hu-berlin.de
Affiliation and contacts	Slovenia Forest Service, Večna pot 2, 1000 Ljubljana, Slovenia
Title of the Dataset	Slovenian Virgin forests
Data Type	MAP
Data Coverage - Region(s) covered	Slovenia
Data Completeness	Complete inventory
Update status	2015
Object of the dataset	Virgin and long-untouched forests included in the forest reserves of Slovenia
Methodological approach	
Publication Status	UNPUBLISHED
Publication Details	http://www.zgs.si/slo/gozdovi_slovenije/o_gozdovih_slovenije/gozdni_rezervati/index.html
Ownership of the dataset	Slovenian Forest Service
Funding acknowledgment	-
Data Accessibility	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 28

DATASET NAME	*Personal database*
Name	Francesco Maria Sabatini, on behalf of Schwendtner, Oskar
e-mail address	Sabatinf@hu-berlin.de
Affiliation and contacts	Humboldt-Universität zu Berlin, Department of Geography. Unter den Linden 6, 10099, Berlin. Germany
Title of the Dataset	Personal database
Data Type	DATABASE
Data Coverage - Region(s) covered	Spain

Data Completeness	Partial Inventory
Update status	2015
Object of the dataset	Old-growth and long-untouched forests of Spain
Methodological approach	
Publication Status	UNPUBLISHED
Publication Details	
Ownership of the dataset	Oscar Schwendtner
Funding acknowledgment	-
Data Accessibility	Regime 1 - Restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) and their use depends on the permission of the respective data custodian.

Dataset 29

DATASET NAME	*Dynamic edge effects on Boreal forest (Sweden)*
Name	Ruete, Alejandro
e-mail address	aleruete@gmail.com
Affiliation and contacts	Greensway AB, Ullsvägen 29C 75651 Uppsala Sweden
Title of the Dataset	Shapefile and excel file describing the centroids of old growth forest set aside from forest production in central Sweden
Data Type	MAP
Data Coverage - Region(s) covered	Dalarna and Gävleborg counties, Sweden
Data Completeness	PARTIAL SURVEY
Update status	2009
Object of the dataset	We selected old-growth spruce dominated forest stands with edges facing naturally disturbed stands or recurrent clearcuts in order to estimate the effect of edge dynamics on the richness and occupancy of dead wood dwelling fungi (among others). Stands should present similar history without recent fires or alike, and be spruce dominated.
Methodological approach	The forest landscape in the region is strongly influenced by modern forestry, and characterized by even-aged monocultures of conifers, few old trees, and low amounts of deadwood. Old-growth forest remnants are typically few and small, occurring isolated in a matrix of managed forests. 31 old-growth forest stands ranging in size from 0.6 to 398 ha were identified in 1998 as part of a biodiversity monitoring program of fragmented forests of high conservation value. Stands were surveyed twice (1998-2000 and again 2010-2011) with 14 m wide transects divided in segments of 10m, searching for the presence of deadwood and fungi species on them. The type and distance to the most influential edge was estimated in the field for each segment of the transect.
Publication Status	PUBLISHED - Data and Description
Publication Details	Ruete, A., Snäll, T. & Jönsson, M. (2016) Dynamic anthropogenic edge effects on the distribution and diversity of fungi in fragmented old-growth forests. *Ecological Applications*, **26**, 1475-1485.
Ownership of the dataset	The data is own by Dalarna and Gävleborg county administrations, represented by Olle Kellner and Urban Gunnarsson, it is now stored in open repository, A. Ruete has been granted extra permit to share the coordinates

Funding acknowledgment	The study was funded by the Swedish Forest Society (Skogssällskapet) and the Faculty of Natural Resources and Agricultural Sciences, SLU
Data Accessibility	CC 4.0

Dataset 30

DATASET NAME	*WSL-ETH Forest Reserve Network*
Name	Stillhard, Jonas
e-mail address	jonas.stillhard@wsl.ch
Affiliation and contacts	WSL Swiss Federal Institute for Forest, Snow and Landscape Research Research Unit Forest Resources and Management Zürcherstrasse 111 8903 Birmensdorf, Switzerland
Title of the Dataset	The shapefile contains all forest reserves within the WSL-ETH Forest Reserve Network considered to meet the definition of primary forests (levels n5-n10, Buchwald (2005)).
Data Type	MAP
Data Coverage - Region(s) covered	Switzerland
Data Completeness	The dataset contains all forest reserves within the WSL-ETH Forest Reserve Network considered primary forests (levels n5-n10) sensu Buchmann (2005). It does not include other primary forests in Switzerland.
Update status	2016
Object of the dataset	The project objectives are to study forest reserves in Switzerland, focusing on the natural processes of tree regeneration, growth and mortality, the co-existence of tree species, the impact of natural disturbances and climate change on forest succession, and on the value of forest reserves as habitat. This is achieved by continuous monitoring of forest structure, including permanent plots established by ETH since 1948 and by comparison with managed forests. The forests selected for the actual project were all forests considered as primary forests (n5 – n10 sensu Buchwald (2005)) within the ETH-WSL forest reserve network.
Methodological approach	The reserves were selected with respect to forest types, size and data availability. Forest types were selected according to their importance for management, to enable comparisons with managed forests, but include also types for which Switzerland bears a special responsibility (e.g. Stone pine forests). Larger reserves were preferred as well as reserves where ETH had already established a monitoring over forests without monitoring. Most of the reserves have been monitored at least once (except Tiefenwald and Arena, which will be monitored in the coming years). Permanent plots were established in Scatlè, the Swiss National Park, Leihubelwald, St. Jean, Girstel, Pfynwald, Aletschwald, Tamangur and Murgtal. On permanent plots, every tree with DBH >3.9 cm was measured, assessed, stem tagged and stem mapped. Sample plot inventories were carried out in Val Cama – Val Leggia, Aletschwald, Tamangur and Selvasecca. Sample plots consist of two concentric circles of 200 m^2 and 500 m^2. On every sample plot, all living and dead trees with a DBH >6.9 cm on 200 m^2 and all living and dead trees with a DBH >35.9 cm on 500 m^2 were measured and stem mapped.

	Additionally, a regeneration survey and a deadwood assessment was carried out.
Publication Status	The dataset is published online within the 'Forest reserves' dataset of the FOEN (Federal Office of the Environment). The dataset as is was solely generated for the ForestsCO-network.
Publication Details	Brang, P., Heiri, C. & Bugmann, H. (Eds.) (2011) Waldreservate. 50 Jahre natürliche Waldentwicklung in der Schweiz. Birmensdorf, Eidg. Forschungsanstalt WSL; Zürich, ETH Zürich; Bern, Stuttgart, Wien, Haupt. 272 p. Vanoni, M., Bugmann, H., Nötzli, M. & Bigler, C. (2016) Drought and frost contribute to aprubt growth decreases before tree mortality in nine temperate tree species. Forest Ecology and Management, **382**, 41-63. Heiri, C., Wolf, A., Rohrer, L., Brang, P. & Bugmann, H. (2012) Successional pathways in swiss mountain forest reserves. European journal of forest research, **131(2)**, 503-518.
Ownership of the dataset	FOEN (Federal Office of the Envirionment), Species, Ecosystems, Landscape Division.
Funding acknowledgment	The Swiss Federal Office of the Environment (FOEN) co-funds the data acquisition in the reserves within the WSL-ETH Forest Reserve Network.
What data accessibility regime should be assigned to the contributed dataset?	Regime 2 - Semi-restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) but without the need for a specific permission in each single case.

Dataset 31

DATASET NAME	
Name	Oleh Chaskovskyy
e-mail address	oleh.chaskov@nltu.edu.ua
Affiliation and contacts	Ukrainian National Forestry University, department of forestry, Gen. Chuprynky, 103, Lviv-79057, Ukraine
Title of the Dataset	old-growth forests in the Ukrainian Carpathian ecoregion
Data Type	MAP
Data Coverage - Region(s) covered	Ukrainian Carphatian ecoregion
Data Completeness	COMPLETE INVENTORY
Update status	2010
Object of the dataset	forest inventory maps, shapefile describing the distribution of old-growth forests in the Ukrainian Carpathians
Methodological approach	candidate forests were selected and mapped via forest inventory data
Publication Status	UNPUBLISHED
Publication Details	Hamor, F., Dovhanych, Y., Pokynchereda, V., Sukharyuk, D., Bundzyak, Y., Berkela, Y., Voloshchuk, M., Hodovanets, B. & Kabal, M. (2008) Virgin forests of Transcarpathia. Inventory and management., 2008th ed. Rakhiv,
Ownership of the dataset	WWF Ukraine
Funding acknowledgment	
Data Accessibility	Regime 1 - Restricted-access: Data are available for data contributors only (i.e., custodians of other datasets) and their use

	depends on the permission of the respective data custodian.

Dataset 32

DATASET NAME	*OGF/VF UA*
Name	Volosyanchuk Roman
e-mail address	volosyanchuk@yahoo.com
Affiliation and contacts	WWF Danube-Carpathian Programme in Ukraine, Mushaka, 42, Lviv, Ukraine
Title of the Dataset	Shapefile with polygons and attributive data of the Old-Growth including Virgin Forests in Ukrainian Carpathians
Data Type	MAP
Data Coverage - Region(s) covered	Ukrainian Carpathians
Data Completeness	PARTIAL SURVEY
Update status	2016
Object of the dataset	Mapping of existing areas of pristine/old-growth forests that should be maintained through non-intervention management. More description at: http://sfmu.org.ua/ua/projects/deg Criteria of virgin forests are used according to the Carpathian Convention, see: http://www.carpathianconvention.org/tl_files/carpathiancon/Downloads/03%20Meetings%20and%20Events/COP/2014_COP4_Mikulov/Follow%20Up/DOC13_Criteria_Indicators_virginforests_FINAL_26SEP.pdf Criteria of OGF have been developed and harmonized for Ukrainian and Romanian Carpathian region, see: http://sfmu.org.ua/files/OGF_PF_metodychka_-A5.pdf
Methodological approach	Candidate forests (potential OGF) were selected using the forestry inventory data and then checked in the field by visiting every plot by especially trained experts. All the methodology is described at: http://sfmu.org.ua/files/OGF_PF_metodychka_-A5.pdf (in Ukrainian language).
Publication Status	Results published at: http://gis-wwf.com.ua/ raw data are not publicly available.
Publication Details	http://gis-wwf.com.ua/
Ownership of the dataset	WWF Danube-Carpathian Programme Ukraine
Funding acknowledgment	1) Open borders for bears between Romanian and Ukrainian Carpathians, ENPI-East CBC, HUSKROUA/1001/038; 2) Support Responsible Forest Management for a Sustainable Development in the Ukrainian Carpathians, DEG-PPP, 9E0710.04-06; 3) Support Responsible Forest Management for a Sustainable Development in the Danube – Carpathian Ecoregion, IKEA, 9E0710.05, 100104; 4) Identification and protection of old-growth and virgin forest in the Ukrainian Carpathians, Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit / Michael Succow Foundation, P 612 A 1095 / UBA76856
Data Accessibility	Data are available to a wider community of users. These data can be made available on request to non-members after submitting a request to the FORESTS and CO, with special approval from WWF DCP Ukraine

Appendix 3 – Reference list of literature review

Aakala, T., Kuuluvainen, T., Wallenius, T. & Kauhanen, H. (2009) Contrasting patterns of tree mortality in late-successional Picea abies stands in two areas in northern Fennoscandia. *Journal of Vegetation Science,* **20,** 1016-1026.

Arnan, X., Comas, L., Gracia, M. & Retana, J. (2014) Composition and habitat use of small mammals in old-growth mountain forests. *Journal of Natural History,* **48,** 481-494.

Bartkowicz, L., Kolodziej, Z. & Pach, M. (2015) Role of tree species in the formation of a complex vertical structure of deciduous old-growth forests in the Niepolomice Forest. *Sylwan,* **159,** 650-657.

Blaško, R., Holm Bach, L., Yarwood, S.A., Trumbore, S.E., Högberg, P. & Högberg, M.N. (2015) Shifts in soil microbial community structure, nitrogen cycling and the concomitant declining N availability in ageing primary boreal forest ecosystems. *Soil Biology and Biochemistry,* **91,** 200-211.

Bolte, A., Kampf, F. & Hilbrig, L. (2013) Space sequestration below ground in old-growth spruce-beech forests – signs for facilitation? *Frontiers in Plant Science,* **4**.

Castagneri, D., Nola, P., Motta, R. & Carrer, M. (2014) Summer climate variability over the last 250 years differently affected tree species radial growth in a mesic Fagus–Abies–Picea old-growth forest. *Forest Ecology and Management,* **320,** 21-29.

Clear, J.L., Seppä, H., Kuosmanen, N. & Bradshaw, R.H.W. (2015) Holocene stand-scale vegetation dynamics and fire history of an old-growth spruce forest in southern Finland. *Vegetation History and Archaeobotany,* **24,** 731-741.

Diaci, J. (1999) Virgin forests and forest reserves in Central and East European countries-History, present status and future development. *Proceedings of the invited lecturers' reports presented at the COST E4 management committee and working groups meeting in Ljubljana, Slovenia*. Department of Forestry and Renewable Forest Resources Biotechnical Faculty, Ljubljana

Diaci, J., Adamic, T. & Rozman, A. (2012) Gap recruitment and partitioning in an old-growth beech forest of the Dinaric Mountains: Influences of light regime, herb competition and browsing. *Forest Ecology and Management,* **285,** 20-28.

Diaci, J., Rozenbergar, D., Anic, I., Mikac, S., Saniga, M., Kucbel, S., Visnjic, C. & Ballian, D. (2011) Structural dynamics and synchronous silver fir decline in mixed old-growth mountain forests in Eastern and Southeastern Europe. *Forestry,* **84,** 479-491.

Dittrich, S., Jacob, M., Bade, C., Leuschner, C. & Hauck, M. (2014) The significance of deadwood for total bryophyte, lichen, and vascular plant diversity in an old-growth spruce forest. *Plant Ecology,* **215,** 1123-1137.

Dodelin, B. (2010) Saproxylic beetle biodiversity in old-growth forests of the south-east of France. *Plant Biosystems - An International Journal Dealing with all Aspects of Plant Biology,* **144,** 262-270.

Esseen, P.-A. (2006) Edge influence on the old-growth forest indicator lichen Alectoria sarmentosa in natural ecotones. *Journal of Vegetation Science,* **17,** 185-194.

Fichtner, A., Forrester, D.I., Härdtle, W., Sturm, K. & von Oheimb, G. (2015) Facilitative-Competitive Interactions in an Old-Growth Forest: The Importance of Large-Diameter Trees as Benefactors and Stimulators for Forest Community Assembly. *Plos One,* **10,** e0120335.

Fraver, S., D'Amato, A.W., Bradford, J.B., Jonsson, B.G., Jönsson, M. & Esseen, P.A. (2014) Tree growth and competition in an old-growth Picea abies forest of boreal Sweden: influence of tree spatial patterning. *Journal of Vegetation Science,* **25,** 374-385.

Gömöryová, E., Ujházy, K., Martinák, M. & Gömöry, D. (2013) Soil microbial community response to variation in vegetation and abiotic environment in a temperate old-growth forest. *Applied Soil Ecology,* **68,** 10-19.
Granata, M., Gratani, L., Bracco, F., Sartori, F. & Catoni, R. (2016) Carbon stock estimation in an unmanaged old-growth forest: a case study from a broad-leaf deciduous forest in the Northwest of Italy. *International Forestry Review,* **18,** 444-451.
Hegland, S.J., Lilleeng, M.S. & Moe, S.R. (2013) Old-growth forest floor richness increases with red deer herbivory intensity. *Forest Ecology and Management,* **310,** 267-274.
Horak, J. & Pavlicek, J. (2013) Tree level indicators of species composition of saproxylic beetles in old-growth mountainous spruce–beech forest through variation partitioning. *Journal of Insect Conservation,* **17,** 1003-1009.
Hytteborn, H. & Verwijst, T. (2014) Small-scale disturbance and stand structure dynamics in an old-growth Picea abies forest over 54 yr in central Sweden. *Journal of Vegetation Science,* **25,** 100-112.
Ingerpuu, N., Vellak, K. & Möls, T. (2007) Growth of Neckera pennata, an epiphytic moss of old-growth forests. *The Bryologist,* **110,** 309-318.
Jabin, M., Topp, W., Kulfan, J. & Zach, P. (2008) The distribution pattern of centipedes in four primeval forests of central Slovakia. *Biodiversity and Conservation in Europe* (eds D.L. Hawksworth & A.T. Bull), pp. 195-203. Springer Netherlands, Dordrecht.
Janda, P., Svoboda, M., Bače, R., Čada, V. & Peck, J.E. (2014) Three hundred years of spatio-temporal development in a primary mountain Norway spruce stand in the Bohemian Forest, central Europe. *Forest Ecology and Management,* **330,** 304-311.
Janík, D., Adam, D., Hort, L., Král, K., Samonil, P., Unar, P. & Vrska, T. (2016a) Breaking through beech: A three-decade rise of sycamore in old-growth European forest. *Forest Ecology and Management,* **366,** 106-117.
Janík, D., Adam, D., Hort, L., Král, K., Šamonil, P., Unar, P. & Vrška, T. (2016b) Patterns of Fraxinus angustifolia in an alluvial old-growth forest after declines in flooding events. *European Journal of Forest Research,* **135,** 215-228.
Janik, D., Adam, D., Vrška, T., Hort, L., Unar, P., Král, K., Šamonil, P. & Horal, D. (2011) Field maple and hornbeam populations along a 4-m elevation gradient in an alluvial forest. *European Journal of Forest Research,* **130,** 197-208.
Jankovský, L., Lička, D. & Ježek, K. (2004) Inventory of dead wood in the Kněhyně-Čertův mlýn National Nature Reserve, the Moravian-silesian Beskids. *Journal of Forest Science,* **50,** 171-180.
Jaworski, A., Kolodziej, Z. & Porada, K. (2002) Structure and dynamics of stands of primeval character in selected areas of the Bieszczady National Park. *J. For. Sci,* **48,** 185-201.
Jaworski, A. & Paluch, J. (2001) Structure and dynamics of the lower mountain zone forests of primeval character in the Babia Góra Mt. National Park. *J. For. Sci,* **47,** 60-74.
Johansson, T., Olsson, J., Hjältén, J., Jonsson, B.G. & Ericson, L. (2006) Beetle attraction to sporocarps and wood infected with mycelia of decay fungi in old-growth spruce forests of northern Sweden. *Forest Ecology and Management,* **237,** 335-341.
Kaiser, K., Guggenberger, G., Haumaier, L. & Zech, W. (2001) Seasonal variations in the chemical composition of dissolved organic matter in organic forest floor layer leachates of old-growth Scots pine (Pinus sylvestris L.) and European beech (Fagus sylvatica L.) stands in northeastern Bavaria, Germany. *Biogeochemistry,* **55,** 103-143.
Keren, S., Motta, R., Govedar, Z., Lucic, R., Medarevic, M. & Diaci, J. (2014) Comparative Structural Dynamics of the Janj Mixed Old-Growth Mountain Forest in Bosnia and Herzegovina: Are Conifers in a Long-Term Decline? *Forests,* **5,** 1243-1266.
Kirchmeir, H. & Kovarovics, A. (2016) Nomination Dossier "Primeval Beech Forests of the Carpathians and Other Regions of Europe“ as extension to the existing Natural World

Heritage Site "Primeval Beech Forests of the Carpathians and the Ancient Beech Forests of Germany" (1133bis). pp. 409. Klagenfurt.

Komonen, A. (2005) Local spatial pattern in the occurrence of two congeneric wood-decaying fungi in an old-growth boreal forest. *Scandinavian Journal of Forest Research,* **20,** 393-399.

Kornan, M. (2013) Breeding bird assemblage dynamics of a primaeval temperate mixed forest in the Western Carpathians (Slovakia): support for pluralistic community concept. *Ornis Fennica,* **90,** 151.

Korňan, M. & Adamík, P. (2004) Structure of the Breeding Bird Assemblage of A Natural Beech-Spruce Forest in the Šútovská Dolina National Nature Reserve, the Malá Fatra Mts. *Ekologia,* **33,** 138-150.

Korpel, S. (1997) Totholz in Naturwäldern und Konsequenzen für Naturschutz und Forstwirtschaft. *Forst und Holz,* **52,** 619-624.

Král, K., McMahon, S.M., Janík, D., Adam, D. & Vrška, T. (2014) Patch mosaic of developmental stages in central European natural forests along vegetation gradient. *Forest Ecology and Management,* **330,** 17-28.

Král, K., Shue, J., Vrška, T., Gonzalez-Akre, E.B., Parker, G.G., McShea, W.J. & McMahon, S.M. (2016) Fine-scale patch mosaic of developmental stages in Northeast American secondary temperate forests: the European perspective. *European Journal of Forest Research,* **135,** 981-996.

Kucbel, S., Saniga, M., Jaloviar, P. & Vencurik, J. (2012) Stand structure and temporal variability in old-growth beech-dominated forests of the northwestern Carpathians: A 40-years perspective. *Forest Ecology and Management,* **264,** 125-133.

Kuuluvainen, T. & Kalmari, R. (2003) Regeneration microsites of Picea abies seedlings in a windthrow area of a boreal old-growth forest in southern Finland. *Annales Botanici Fennici,* pp. 401-413. JSTOR.

Laaka-Lindberg, S., Pohjamo, M. & Korpelainen, H. (2005) Niche breadth and niche overlap in three epixylic hepatics in a boreal old-growth forest, southern Finland. *Journal of Bryology,* **27,** 119-127.

Lähde, E., Eskelinen, T. & Väänänen, A. (2002) Growth and diversity effects of silvicultural alternatives on an old-growth forest in Finland. *Forestry,* **75,** 395-400.

Lankia, H., Wallenius, T., Várkonyi, G., Kouki, J. & Snäll, T. (2012) Forest fire history, aspen and goat willow in a Fennoscandian old-growth landscape: are current population structures a legacy of historical fires? *Journal of Vegetation Science,* **23,** 1159-1169.

Leuschner, C., Hertel, D., Schmid, I., Koch, O., Muhs, A. & Hölscher, D. (2004) Stand fine root biomass and fine root morphology in old-growth beech forests as a function of precipitation and soil fertility. *Plant and Soil,* **258,** 43-56.

Lõhmus, A., Lõhmus, P., Remm, J. & Vellak, K. (2005) Old-growth structural elements in a strict reserve and commercial forest landscape in Estonia. *Forest Ecology and Management,* **216,** 201-215.

Lombardi, F., Marchetti, M., Corona, P., Merlini, P., Chirici, G., Tognetti, R., Burrascano, S., Alivernini, A. & Puletti, N. (2015) Quantifying the effect of sampling plot size on the estimation of structural indicators in old-growth forest stands. *Forest Ecology and Management,* **346,** 89-97.

Lundqvist, L. & Nilson, K. (2007) Regeneration dynamics in an uneven-aged virgin Norway spruce forest in northern Sweden. *Scandinavian Journal of Forest Research,* **22,** 304-309.

Matula, R., Svátek, M., Pálková, M., Volařík, D. & Vrška, T. (2015) Mistletoe infection in an oak forest is influenced by competition and host size. *Plos One,* **10,** e0127055.

Maycock, P.F., Guzik, J., Jankovic, J., Shevera, M. & Carleton, T.J. (2000) Composition, structure and ecological aspects of mesic old growth Carpathian deciduous forests of Slovakia, Southern Poland and the Western Ukraine. *Fragmenta Floristica et Geobotanica,* **45,** 281-321.

Mazziotta, A., Heilmann-Clausen, J., Bruun, H.H., Fritz, Ö., Aude, E. & Tøttrup, A.P. (2016) Restoring hydrology and old-growth structures in a former production forest: Modelling the long-term effects on biodiversity. *Forest Ecology and Management,* **381,** 125-133.

Merganicova, K., Merganic, J. & Hasenauer, H. (2012) Assessing the Carbon Flux Dynamics within Virgin Forests: The Case Study'Babia hora'in Slovakia. *AUSTRIAN JOURNAL OF FOREST SCIENCE,* **129,** 1-21.

Mikac, S., Klopf, M., Anić, I. & Hasenauer, H. (2013) Using the tree growth model MOSES to assess the dynamics of Dinaric old-growth mixed beech–fir forest ecosystems. *Plant Biosystems,* **147,** 664-671.

Motta, R., Garbarino, M., Berretti, R., Bjelanovic, I., Borgogno Mondino, E., Čurović, M., Keren, S., Meloni, F. & Nosenzo, A. (2015) Structure, spatio-temporal dynamics and disturbance regime of the mixed beech–silver fir–Norway spruce old-growth forest of Biogradska Gora (Montenegro). *Plant Biosystems,* **149,** 966-975.

Nascimbene, J., Brunialti, G., Ravera, S., Frati, L. & Caniglia, G. (2010) Testing Lobaria pulmonaria (L.) Hoffm. as an indicator of lichen conservation importance of Italian forests. *Ecological Indicators,* **10,** 353-360.

Nopp-Mayr, U., Kempter, I., Muralt, G. & Gratzer, G. (2015) Herbivory on young tree seedlings in old-growth and managed mountain forests. *Ecological Research,* **30,** 479-491.

Ojala, E., Mönkkönen, M. & Inkeröinen, J. (2000) Epiphytic bryophytes on European aspen Populus tremula in old-growth forests in northeastern Finland and in adjacent sites in Russia. *Canadian Journal of Botany,* **78,** 529-536.

Ostojić, D., Jovanović, B. & Kisin, B. (2008) Beech Virgin Reserves in Serbia. *III Congress of Ecologists of the Republic of Macedonia with International Participation. 06-09.10.2007*, pp. 86-91. Special issues of Macedonian Ecological Society, Struga.

Paluch, J.G., Kołodziej, Z., Pach, M. & Jastrzębski, R. (2014) Spatial variability of close-to-primeval Fagus–Abies–Picea forests in the Western Carpathians (Central Europe): a step towards a generalised pattern. *European Journal of Forest Research,* **134,** 235-246.

Panajiotidis, S. & Fotiadis, G. (2001) Vegetation units of riparian forest remnants of central Macedonia (N. Greece). *Scientific Annals of School of Forestry & N.E [In Greek with Engish summary],* **44,** 177-188.

Panayotov, M., Kulakowski, D., Laranjeiro Dos Santos, L. & Bebi, P. (2011) Wind disturbances shape old Norway spruce-dominated forest in Bulgaria. *Forest Ecology and Management,* **262,** 470-481.

Peck, J.E., Commarmot, B., Hobi, M.L. & Zenner, E.K. (2015) Should reference conditions be drawn from a single 10 ha plot? Assessing representativeness in a 10,000 ha old-growth European beech forest. *Restoration Ecology,* **23,** 927-935.

Petritan, I.C., Commarmot, B., Hobi, M.L., Petritan, A.M., Bigler, C., Abrudan, I.V. & Rigling, A. (2015) Structural patterns of beech and silver fir suggest stability and resilience of the virgin forest Sinca in the Southern Carpathians, Romania. *Forest Ecology and Management,* **356,** 184-195.

Petritan, I.C., Marzano, R., Petritan, A.M. & Lingua, E. (2014) Overstory succession in a mixed Quercus petraea–Fagus sylvatica old growth forest revealed through the spatial pattern of competition and mortality. *Forest Ecology and Management,* **326,** 9-17.

Pittner, J. & Saniga, M. (2008) A change in structural diversity and regeneration processes of the spruce virgin forest in Nefcerka NNR (TANAP) in relation to altitude. *Journal of Forest Science,* **54,** 545-553.
Richard, F., Millot, S., Gardes, M. & Selosse, M.A. (2005) Diversity and specificity of ectomycorrhizal fungi retrieved from an old-growth Mediterranean forest dominated by Quercus ilex. *New Phytologist,* **166,** 1011-1023.
Rozas, V. (2006) Structural heterogeneity and tree spatial patterns in an old-growth deciduous lowland forest in Cantabria, northern Spain. *Plant Ecology,* **185,** 57-72.
Sabatini, F., Jiménez-Alfaro, B., Burrascano, S. & Blasi, C. (2014a) Drivers of herb-layer species diversity in two unmanaged temperate forests in northern Spain. *Community Ecology,* **15,** 147-157.
Sabatini, F.M., Burrascano, S., Tuomisto, H. & Blasi, C. (2014b) Ground Layer Plant Species Turnover and Beta Diversity in Southern-European Old-Growth Forests. *Plos One,* **9,** e95244.
Šamonil, P., Daněk, P., Schaetzl, R., Vašíčková, I. & Valtera, M. (2015) Soil mixing and genesis as affected by tree uprooting in three temperate forests. *European Journal of Soil Science,* **66,** 589-603.
Scattolin, L., Lancellotti, E., Franceschini, A. & Montecchio, L. (2014) The ectomycorrhizal community in Mediterranean old-growth Quercus ilex forests along an altitudinal gradient. *Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology,* **148,** 74-82.
Schrumpf, M., Kaiser, K. & Schulze, E.-D. (2014) Soil Organic Carbon and Total Nitrogen Gains in an Old Growth Deciduous Forest in Germany. *Plos One,* **9,** e89364.
Šebesta, J., Šamonil, P., Lacina, J., Oulehle, F., Houška, J. & Buček, A. (2011) Acidification of primeval forests in the Ukraine Carpathians: Vegetation and soil changes over six decades. *Forest Ecology and Management,* **262,** 1265-1279.
Seedre, M., Kopáček, J., Janda, P., Bače, R. & Svoboda, M. (2015) Carbon pools in a montane old-growth Norway spruce ecosystem in Bohemian Forest: Effects of stand age and elevation. *Forest Ecology and Management,* **346,** 106-113.
Sjoberg, K., Pettersson, R.B., Ball, J.P. & Sundstrom, T. (2007) Seed crops of Norway spruce and winter habitat quality for boreal birds: old-growth compared with managed forests. *Annales Zoologici Fennici,* **44,** 486-495.
Sjögren, P. & Kirchhefer, A.J. (2012) Historical legacy of the old-growth pine forest in Dividalen, northern Scandes. *International Journal of Biodiversity Science, Ecosystem Services & Management,* **8,** 338-350.
Svensson, J.S. & Jeglum, J.K. (2001) Structure and dynamics of an undisturbed old-growth Norway spruce forest on the rising Bothnian coastline. *Forest Ecology and Management,* **151,** 67-79.
Svoboda, M., Janda, P., Bače, R., Fraver, S., Nagel, T.A., Rejzek, J., Mikoláš, M., Douda, J., Boublík, K., Šamonil, P., Čada, V., Trotsiuk, V., Teodosiu, M., Bouriaud, O., Biriş, A.I., Sýkora, O., Uzel, P., Zelenka, J., Sedlák, V. & Lehejček, J. (2014) Landscape-level variability in historical disturbance in primary Picea abies mountain forests of the Eastern Carpathians, Romania. *Journal of Vegetation Science,* **25,** 386-401.
Tinya, F. & Ódor, P. (2016) Congruence of the spatial pattern of light and understory vegetation in an old-growth, temperate mixed forest. *Forest Ecology and Management,* **381,** 84-92.
Tíscar, P.A. & Lucas-Borja, M.E. (2016) Structure of old-growth and managed stands and growth of old trees in a Mediterranean Pinus nigra forest in southern Spain. *Forestry,* cpw002.

Topoliantz, S. & Ponge, J.F. (2000) Influence of site conditions on the survival of Fagus sylvatica seedlings in an old-growth beech forest. *Journal of Vegetation Science,* **11,** 369-374.
Trotsiuk, V., Svoboda, M., Janda, P., Mikolas, M., Bace, R., Rejzek, J., Samonil, P., Chaskovskyy, O., Korol, M. & Myklush, S. (2014) A mixed severity disturbance regime in the primary Picea abies (L.) Karst. forests of the Ukrainian Carpathians. *Forest Ecology and Management,* **334,** 144-153.
Tsiripidis, I. & Athanasiadis, N. (2003) Contribution to the knowledge of the vascular flora of NE Greece: Floristic composition of the beech (Fagus sylvatica L.) forests in the Greek Rodopi. *Willdenowia***,** 273-297.
Vandekerkhove, K., van Dort, K., Baeté, H. & Walleyn, R. (2001) Species richness of mosses, fungi and vascular plants on coarse woody debris of beech in the Flemish forest reserveKersselaerspleyn'(Zonienwoud). *Scripta Botanica Belgica,* **24,** 83-92.
Vašíčková, I., Šamonil, P., Ubilla, A.E.F., Král, K., Daněk, P. & Adam, D. (2016) The true response of Fagus sylvatica L. to disturbances: A basis for the empirical inference of release criteria for temperate forests. *Forest Ecology and Management,* **374,** 174-185.
Višnjić, Ć., Solaković, S., Mekić, F., Balić, B., Vojniković, S., Dautbašić, M., Gurda, S., Ioras, F., Ratnasingam, J. & Abrudan, I.V. (2013) Comparison of structure, regeneration and dead wood in virgin forest remnant and managed forest on Grmeč Mountain in Western Bosnia. *Plant Biosystems,* **147,** 913-922.
Vondrák, J., Malícek, J., Šoun, J. & Pouska, V. (2015) Epiphytic Lichens of Stuzica (E Slovakia) in the Context of Central European Old-Growth Forests. *Herzogia,* **28,** 104-126.
Vrška, T., Adam, D., Hort, L., Kolář, T. & Janík, D. (2009) European beech (Fagus sylvatica L.) and silver fir (Abies alba Mill.) rotation in the Carpathians—A developmental cycle or a linear trend induced by man? *Forest Ecology and Management,* **258,** 347-356.
Vrska, T., Hort, L., Odehnalová, P., Adam, D. & Horal, D. (2001) The Milesice virgin forest after 24 years (1972–1996). *Journal of Forest Science,* **47,** 255-276.
Vrška, T., Janík, D., Pálková, M., Adam, D. & Trochta, J. (2016) Below-and above-ground biomass, structure and patterns in ancient lowland coppices. *Iforest-Biogeosciences and Forestry,* **10,** 23.
Vrška, T., Šamonil, P., Unar, P., Hort, L., Adam, D., Král, K. & Janík, D. (2012) Developmental dynamics of virgin forest reserves in the Czech Republic III–Šumava Mts. and Ceský les Mts. *Diana, Stozec, Boubín virgin forests, Milešice virgin forest. Academia, Prague.*
Westergren, M., Bozic, G., Ferreira, A. & Kraigher, H. (2015) Insignificant effect of management using irregular shelterwood system on the genetic diversity of European beech (Fagus sylvatica L.): A case study of managed stand and old growth forest in Slovenia. *Forest Ecology and Management,* **335,** 51-59.
Westphal, C., Tremer, N., Oheimb, G.v., Hansen, J., Gadow, K.v. & Härdtle, W. (2006) Is the reverse J-shaped diameter distribution universally applicable in European virgin beech forests? *Forest Ecology and Management,* **223,** 75-83.
Ziaco, E., Di Filippo, A., Alessandrini, A., Baliva, M., D'andrea, E. & Piovesan, G. (2012) Old-growth attributes in a network of Apennines (Italy) beech forests: Disentangling the role of past human interferences and biogeoclimate. *Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology,* **146,** 153-166.

Appendix 4 – Definition framework

In this work we adopted the definition framework developed by Buchwald (2005), during the Third Expert Meeting on Harmonizing Forest-related Definitions, organized by FAO in Rome in January 2005. The meeting aimed at tackling the problem of the ambiguous use of forest-related definitions in various international processes and we adopted it for being authoritative, and because it proved to be flexible enough, to allow us overcome methodological and conceptual differences between definitions used across different European countries.

This framework identifies 14 mutually exclusive levels of forest naturalness, and incorporate the most logical and generally accepted parts of existing definitions. Below, we report the names of the 14 levels, as well as the definitions for those levels that are the object of our research. We refer the reader to the original publication for the philosophical background of this approach and additional details (Buchwald, 2005).

Levels of Naturalness

- **n10 – Primeval forest**
- **n9 – Virgin forest**
- **n8 – Frontier forest**
- **n7 – Near-virgin forest**
- **n6 – Old-growth forest**
- **n5 – Long-untouched forest**
- n4 – Newly-untouched forest
- n3 – Specially managed forest
- n2 – Exploited natural forest
- n1 – Plantation-like natural forest
- p4 – Partly-natural planted forest
- p3 – Native plantation
- p2 – Exotic plantation
- p1 – Self-sown exotic forest

Buchwald (2005) defines as primary forests all those forests having a naturalness level comprised between n10 and n5 (bold).

Notes:

1. Every naturalness level applies to a specific spatial scale. Levels n10 and n8 apply at landscape scale. Levels n9 and n7 apply at forest scale, while all the others apply at stand scale (Buchwald, 2005). For the purpose of this manuscript, we set as thresholds for the landscape-scale an extent greater than 500 km^2 (so to be consistent with the concept of Intact Forest Landscape (Potapov et al., 2017), and for forest scale a minimum size of 250 ha. This means that the naturalness levels n10 and n8 could only be assigned to primary forest patches greater than 500 km^2, and the naturalness levels n7 and n9 could only be assigned to primary forest patches greater than 250 ha.
2. We assumed the definition of primary forest reported by Buchwald as conceptually equivalent to FAO definition of primary forest (FAO, 2015). For clarity we report below also the definition of ‘Forest undisturbed by man’ used (FOREST EUROPE, 2015), which is also considered as being equivalent to FAO’s definition.
3. Given the millennia of anthropogenic activities in European forests, for the scopes of this manuscript we conservatively avoided to attribute the highest levels of naturalness (n10-n8) to the primary forest patches we mapped.

Buchwald's definitions of naturalness levels consistent with primary forest (n10-n5)
Definitions below come from Buchwald (2005).

Primary forests (n10-n5): *Relatively intact forest areas that have always or at least for the past sixty to eighty years been essentially unmodified by human activity. Human impacts in such forest areas have normally been limited to low levels of hunting, fishing and harvesting of forest products, and, in some cases, to historical or pre-historical low intensity agriculture.*

n10 Ultimate degree of naturalness – Primeval Forest – *Forest ecosystems never modified by modern man/civilization even indirectly, where the degree of impact on the ecosystem by indigenous people has not been significantly higher than the impacts of natural wildfire and of large wild animals (e.g. beaver or megaherbivores). The fauna includes a rich host of large animal species and is not significantly affected by human-induced extinctions or changes to animal population densities. Size is landscape-scale. […]*

n9 Extremely high degree of naturalness – Virgin Forest – *Forest ecosystems virtually unmodified by man, and where the degree of former human impact on the forest – including soil and hydrology – has been only slightly more significant than the impacts of wildfire and animals (e.g. beaver or megaherbivores), and is no longer obvious. Wildlife inhabits the area with a fairly natural density and species composition including large herbivores and carnivores. Size is forest-scale. […]*

n8 Very high degree of naturalness – Frontier forest – *A frontier forest is an area meeting the following criteria: it is primarily forested and predominantly consists of indigenous tree species. It is big enough to support viable populations of all indigenous species associated with that forest type […] even in the face of the natural disasters – such as hurricanes, fires, and pest or disease outbreaks – that might occur there in a century. It is home to most, if not all, of the other plant and animal species that typically live in this type of forest. Its structure and composition are determined mainly by natural events, though limited human disturbance by traditional activities of the sort that have shaped forests for thousands of years -such as low-density shifting cultivation – may be acceptable. As such, it remains relatively unmanaged by humans, and natural disturbances (such as fire) are permitted to shape much of the forest. In forests where patches of trees of different ages would naturally occur, the landscape exhibits this type of heterogeneity. (Rearranged/shortened from World Ress. Inst.:http://www.wri.org/ffi/lff-eng/).*

n7 Very high degree of naturalness – Near-virgin forest – *Forest ecosystems (forest scale) untouched long enough to have attained structures, dynamics and species composition similar to virgin forest, even though they may have been significantly modified, e.g. by clearcutting or agriculture at some time in the past. They are distinguished by a mixture in time and space between different seral stages, e.g. between old-growth stages and younger stages. Human impact on the forest structures is not obvious to see. The time necessary in untouched development before this level can be reached depends on how modified the situation was at the start. It is at least several hundred years if the starting point is a plantation-like forest.*

n6 High degree of naturalness – Old-growth forest – *Ecosystems (stand scale) distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics which may include tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function. The age at which old-growth develops and the specific structural attributes that characterise old-growth will vary widely according to forest type, climate, site conditions, and disturbance regime. […] However, old-growth is typically distinguished from younger growth by several of the following attributes: 1) large trees for species and site, 2) wide variation in tree sizes and spacing, 3) accumulations of large-size dead standing and fallen trees that are high relative to earlier stages, 4) decadence in the form of broken or deformed tops or bole and root decay, 5)* *multiple canopy layers, and 6) canopy gaps and understory patchiness. Old-growth is not necessarily "virgin" or "primeval." Old-growth can develop following human disturbance […]*

n5 Quite high degree of naturalness – Long untouched forest – *Relatively intact forest (stand level) that has been essentially unmodified by human activity for the past sixty to eighty years or for an unknown, but relatively long time. Signs of former human impacts may still be visible, but strongly blurred due to the decades without forestry operations. The time limit depends on how modified the forest was at the starting point. […]*

Other definitions relevant to the scopes of this manuscript

Primary forest – FAO definition (FAO, 2015): *Naturally regenerated forest of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.*

Explanatory note
Some key characteristics of primary forests are:

- they show natural forest dynamics, such as natural tree species composition, occurrence of dead wood, natural age structure and natural regeneration processes;
- the area is large enough to maintain its natural characteristics;
- there has been no known significant human intervention or the last significant human intervention was long enough ago to have allowed the natural species composition and processes to have become re-established.

Forest undisturbed by man (FOREST EUROPE, 2015): *naturally regenerated stands of native species, with natural dynamics (which requires sufficient area and natural structures). They are always of high nature conservation value. No clearly visible indications of human activities are acceptable.*

Note: Forest undisturbed by man is considered equivalent to FAO's primary forest in Forest Europe's work.

References

Buchwald, E. (2005) A hierarchical terminology for more or less natural forests in relation to sustainable management and biodiversity conservation. *Proceedings: Third expert meeting on harmonizing forest-related definitions for use by various stakeholders* Food and Agriculture Organization of the United Nations, Rome, 17-19 January 2005.

FAO (2015) Global Forest Resources Assessment 2015. Terms and definitions. In: *Forest resources Assessment Working Paper 180*, p. 36. FAO, Rome.

FOREST EUROPE (2015) State of Europe's Forests 2015.

Potapov, P., Hansen, M.C., Laestadius, L., Turubanova, S., Yaroshenko, A., Thies, C., Smith, W., Zhuravleva, I., Komarova, A., Minnemeyer, S. & Esipova, E. (2017) The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013. *Science Advances,* **3**

Supporting Information

To Sabatini et al. 2017. Where are Europe's last primary forests?
In review for: Diversity and Distributions

Table S1 – Geodatabase architecture

Table S1 – Architecture of the geodatabase of European primary forests

* required fields ‡ required field for point datasets

Variable Name	Variable_type	Description and possible values
OBJECTID	Object ID	
FORESTS_NAME*	Text	Name of the forest stand
LOCATION*	Text	Municipality in which the the primary forest remnant is located
NATURALNESS_LEVEL*	Short Integer	Naturalness level according to Buchwald (2005): n10 - Primeval Forest, n9 - Virgin Forest, n8 - Frontier Forest, n7 - Near-virgin Forest, n6 - Old-growth Forest, n5 - Long Untouched Forest
FOREST_EXTENT_MEASURED‡	Double	The total extent of the primary forest remnant patch in hectares. This field is only relevant when a polygon feature IS NOT available for the forest patch.
FOREST_EXTENT_ESTIMATED‡	Short Integer	The order of magnitude of the extend of a primary forest remnant patch. This field is only relevant when a polygon feature IS NOT available for the forest patch and no precise measurement of the total extent of the forest remnant is available. Possible values: 1. 1-10 ha 2. 11-100 ha 3. 101-1000 ha 4. >1001 ha
DOMINANT_TREE_SPECIES1*	Text	Species (latin name) of the dominant tree species of the overstorey
DOMINANT_TREE_SPECIES2	Text	Species (latin name) of the second dominant tree species of the overstorey (if any)
DOMINANT_TREE_SPECIES3	Text	Species (latin name) of the third dominant tree species of the overstorey (if any)
PROTECTED_SINCE	Short Integer	Year since the onset of legal protection
PROTECTION_STATUS	Short Integer	binary, yes\no
THREATS_1	Short Integer	Threat (if any) that is most likely to endanger the primary forest remnant (drop-down list). Possible values: Plantation development Antrhopogenic Fires Tourism/recreation Infrastructure development (including touristic)

		Mismanagement Illegal logging Timber and fuelwood extraction Non-Timber Forest Products extraction Urbanization and housing construction Climate change Biodiversity loss Diseases/pests Agricultural expansion Hunting Invasive Species OTHER
THREATS_2	Short Integer	Threat (if any) that is most likely to endanger the primary forest remnant (drop-down list). See above for possible values)
LAST_DISTURBANCE1_EVENT_TYPE	Text	If known, type of the last disturbance event (drop-down list) Fire Windthrow Flood Landslide Avalanche Logging\harvesting Diseases\pests outbreak OTHER natural OTHER antrhopogenic
LAST_DISTURBANCE1_YEAR	Short Integer	Year when disturbance event 1 happened
LAST_DISTURBANCE1_INTENSITY	Short Integer	Intensity of disturbance event 1 – (Dropdown list) 1. Light (<20% of the stand disturbed)) 2. Moderate (20-70% of the stand disturbed) 3. Stand replacing (>70% of the stand disturbed)
LAST_DISTURBANCE2_EVENT_TYPE	Text	If known, type of the penultimate disturbance event (drop-down list). See above
LAST_DISTURBANCE2_YEAR	Short Integer	Year of disturbance event 2
LAST_DISTURBANCE2_INTENSITY	Short Integer	Intensity of disturbance event 2 – (Dropdown list) see above
CONTACT_PERSON*	Text	Name of the contact person providing the information on the stand
RELEVANT_LITERATURE	Text	Any relevant sources of information describing the forest remnant (including journal articles, local reports and websites)
DATA_AVAILABILITY_REGIME*	Short Integer	At the time of data submission or update, the custodians assign one of the following data availability regimes to the data contributed (Dropdown list) Regime 1 – Restricted-Access Regime 2 – Semi-restricted-Access Regime 3 – Free Access. For details please, check the 'Data Governance Rules' of FORESTS and CO

Table S2 – Summary of primary forest datasets collected

Table S2 - List of dataset collected

#	Country	Custodian	Dataset name	Type of features	# of features	Publication Status
1	Balkans	Martin Mikolas	Forest Ecology Group CULS	Polygons	19	Trotsiuk et al. (2014); Svoboda et al. (2014)
2	Balkans	Matteo Garbarino	LomJanPerBio	Polygons	4	Bottero et al. (2011)
3	Bulgaria	Tzvetan Zlatanov	WWF - Old Forests in Bulgaria	Polygons	127	http://gis.wwf.bg/mobilz_en/
4	Bulgaria	Momchil Panayotov	Coniferous Old-growth forest of Rila and Pirin NP, Bulgaria	Polygons	363	Panayotov et al. (2016)
5	Croatia	Stjepan Mikac	Personal database	Polygons	45	Unpublished
6	Czech Republic	Tomas Vrska	Czech natural forests databank	Polygons	86	http://naturalforests.cz/czech-natural-forests-databank
7	Denmark	Erik Buchwald	Old-growth & long untouched forests of Denmark	Points	24	Unpublished
8	Estonia	Ann Kraut	Hemiboreal old-growth forests of Estonia	Points	23?	Lõhmus and Kraut (2010)
9	Europe	Fabio Lombardi	Literature Review - Foreste Vetuste di faggio	Points	149	EEA (2014)
10	Europe	Hanns Kirchmeir	UNESCO - Primeval Beech Forests	Polygons	15	http://whc.unesco.org/en/list/1133
11	Europe	Hanns Kirchmeir	UNESCO – Primeval Beech Forests Extension	Polygons	67	Kirchmeir and Kovarovics (2016)
12	Finland	Olli-Pekka Tikkanen	Publicly available data on OG forests of Finland	Polygons	681	Derived from http://www.syke.fi/en-US/Open_information
13	France	Daniel Vallauri?	WWF - Hauts lieux de naturalité en France	Polygons	47	http://www.foretsanciennes.fr/proteger-mieux/france/
14	France	Nicolas Debaive	RNF	Polygons	7	Unpublished
15	Germany	Peter Meyer	Naturwaldreservate in Deutschland	Polygons + points	7+7	http://www.naturwaelder.de/

16	Greece	Nikolaos Grigoriadis	“World Heritage Beech Forests of Europe" Greek candidates	Polygons	5	Unpublished
17	Hungary	Ferenc Horváth	Hungarian Forest Reserve monitoring	Polygons	8	Unpublished
18	Italy	Sabina Burrascano	Network Foreste Vetuste nei Parchi Nazionali Italiani	Polygons	67	Blasi et al. (2010)
19	Lituania	Gintautas Mozgeris	Natural forests in Lithuania	Polygons	20	Unpublished
20	Macedonia	Bojan Simovski	Personal database - Old-growth forests in Mavrovo NP	Polygons + points	4+1	Unpublished
21	Norway	Rein Midteng	Old-growth forests in Norway outside protected areas	Polygons	50	Skogkur 2020. Redningsplan for Norges unike skoger
22	Poland	Jerzy Szwagrzyk	Database of old-growth forests of Poland	Polygons	62	Unpublished
23	Portugal	Inês Marques Duarte	Natural forest areas in Portugal	Polygons + points	31+6	Unpublished
24	Portugal	Leónia Nunes	Natural forest areas in Portuguese Macaronesia region	Polygons	15	Unpublished
25	Romania	Costel Bucur\Radu Melu	WWF - Lemnocontrolat	Polygons	1887	http://www.lemncontrolat.ro/en/home/
26	Slovakia	Juraj Vysoky	Prales Database	Polygons	290	http://en.pralesy.sk/
27	Slovenia	Rok Pisek	Grafični prikaz gozdnih rezervatov	Polygons	168	http://www.zgs.si/slo/gozdovi_slovenije/o_gozdovih_slovenije/gozdni_rezervati/index.html
28	Spain	Oscar Schwendtner	Personal database	Points	9	Unpublished
29	Sweden	Alejandro Ruete		Points	10	Ruete et al. (2016)
30	Switzerland	Jonas Stillhard	Strict Forest Reserves in Switzerland	Polygons	16	Tinner et al. (2010; 2012)
31	Ukraine	Oleh Chaskovsky	Virgin Forests of Transcarpathia	Polygons	88	Hamor et al. (2008)
32	Ukraine	Roman Volosyanchuk	WWF - Identified old-growth forests of Ukrainian Carpathians	Polygons	4914	http://gis-wwf.com.ua/

Table S3 – Results of literature review

First.Author	Year	Country	Forest_name	Location	author.definition	Naturalness.level	ha
Blasko	2015	Sweden	UNKNOWN	Island Bjuren	Primary	n6 - Old-growth Forest	
Petritan	2015	Romania	Sinca	Sercaia village	Virgin, Primeval	n6 - Old-growth Forest	323.7
Motta	2015	Montenegro	Biogradska Gora	Kolasin	old-growth	n7 - Near-virgin Forest	1230
Clear	2015	Finland	Sudenpesankangas	Evo	old-growth	n6 - Old-growth Forest	
Peck	2015	Ukraine	Uholka	Uholko-Shyrokoluzhanskiy massif	Primeval, virgin	n7 - Near-virgin Forest	10282
Sabatini	2015	Bosnia-Herzegovina	Perucica	Sutjeska National Park	old-growth	n7 - Near-virgin Forest	1434
Sabatini	2015	Italy	Abeti Soprani	Capracotta	old-growth	n5 - Long Untouched Forest	
Sabatini	2015	Italy	Cervara	Villavallelonga	old-growth	n6 - Old-growth Forest	24
Sabatini	2015	Italy	Collemeluccio	Pietrabbondante	old-growth	n5 - Long Untouched Forest	347
Sabatini	2015	Italy	Fonte Novello	Pietracamela	old-growth	n6 - Old-growth Forest	
Sabatini	2015	Italy	Area Pavari - Gargano	Vico del Gargano	old-growth	n5 - Long Untouched Forest	40
Sabatini	2015	Italy	Monte Cimino	Soriano al Cimino	old-growth	n5 - Long Untouched Forest	62
Sabatini	2015	Italy	MontediMezzo	San Pietro Avellana	old-growth	n5 - Long Untouched Forest	
Sabatini	2015	Italy	Sasso Fratino	Badia Prataglia	old-growth	n6 - Old-growth Forest	764
Sabatini	2015	Spain	Muniellos	Posada de Rengos	old-growth	n5 - Long Untouched Forest	5970
Lombardi	2015	Italy	Bosco Aschiero	Pietracamela	old-growth	n5 - Long Untouched Forest	5
Seedre	2015	Czech Republic	Certovo Lake catchment	Brcalnik	primary, old-growth	n6 - Old-growth Forest	86.9
Vondrak	2015	Slovakia	Stužica	Nová Sedlica	Virgin, old-growth	n7 - Near-virgin Forest	761
Nopp-Mayr	2015	Austria	Wilderness Area Dürrenstein	Rothwald (?)	old-growth	n6 - Old-growth Forest	56
Nopp-Mayr	2015	Austria	Wilderness Area Dürrenstein	Rothwald (?)	old-growth	n6 - Old-growth Forest	240
Fichtner	2015	Germany	Serrahn	Müritz National Park	old-growth	n6 - Old-growth Forest	268
Paluch	2015	Poland	Baniska		primeval	n6 - Old-growth Forest	142
Paluch	2015	Poland	U zrodeł Solinki	Bieszczadzki National Park	primeval	n6 - Old-growth Forest	
Paluch	2015	Poland	Zarnowka	Babia Gora National Park	primeval	n6 - Old-growth Forest	
Westergreen	2015	Slovenia	Rajhenavski Rog	Kocevje	old-growth	n6 - Old-growth Forest	51.1
Bobiec	2012	Poland	Białowieza	Bialowieza National Park	Primeval	n7 - Near-virgin Forest	4747
Janda	2014	Czech Republic	Trojmezna	Sumava National Park	old-growth	n6 - Old-growth Forest	600
Dittrich	2014	Germany	Mt. Brocken	Harz Mountains	old-growth	n6 - Old-growth Forest	300
Petritan	2014	Romania	Runcu-Grosi	Runcu Grosi Natural Reserve	old-growth	n6 - Old-growth Forest	261.8
Keren	2014	Bosnia-Herzegovina	Janj	Sipovo	old-growth, virgin	n6 - Old-growth Forest	57.2
Castagneri	2014	Bosnia-Herzegovina	Lom	Drinic	old-growth	n6 - Old-growth Forest	55.8
Fraver	2014	Sweden	Gardfjället Nature Reserve	Västerbotten County	old-growth	n6 - Old-growth Forest	300
Svoboda	2014	Romania	Giumalau G1	Nature Reserve Giumalau	primary forest	n6 - Old-growth Forest	101
Svoboda	2014	Romania	Calimani C1	Calimani National Park	primary forest	n6 - Old-growth Forest	40
Svoboda	2014	Romania	Calimani C2	Calimani National Park	primary forest	n6 - Old-growth Forest	8
Svoboda	2014	Romania	Calimani C3	Calimani National Park	primary forest	n6 - Old-growth Forest	12
Svoboda	2014	Romania	Calimani C4	Calimani National Park	primary forest	n6 - Old-growth Forest	12
Svoboda	2014	Romania	Calimani C5	Calimani National Park	primary forest	n6 - Old-growth Forest	10
Schrumpf	2014	Germany	Hainich	Hainich National Park		n5 - Long Untouched Forest	600
Scattolin	2014	Italy	Marganai	Domusnovas	old-growth	n5 - Long Untouched Forest	
Scattolin	2014	Italy	Gutturu Mannu	Santadi	old-growth	n5 - Long Untouched Forest	
Scattolin	2014	Italy	Montes	Orgosolo	old-growth	n5 - Long Untouched Forest	
Král	2014	Czech Republic	Zofínský Prales	Novohradské mountains	virgin, old-growth	n6 - Old-growth Forest	75

Table S3 – Results of literature review

First.Author	Year	Country	Forest_name	Location	author.definition	Naturalness.level	ha
Hytteborn	2014	Sweden	Fiby urskog	Vänge	Primeval	n6 - Old-growth Forest	70
Visnjic	2013	Bosnia-Herzegovina	Bobija	Grmec Mountains	Pristine, virgin	n6 - Old-growth Forest	56
Hegland	2013	Norway	Svanøy island		old-growth	n6 - Old-growth Forest	
Horak	2013	Czech Republic	Bukacka Forest	Orlicke Mountains	old-growth	n5 - Long Untouched Forest	50
Bolte	2013	Germany	Rehberg	Harz National Park	old-growth	n5 - Long Untouched Forest	
Bolte	2013	Sweden	Rågetaåsen	Halland	old-growth	n5 - Long Untouched Forest	
Bolte	2013	Sweden	Siggaboda	Blekinge	old-growth	n5 - Long Untouched Forest	
Mikac	2013	Croatia	Corkova uvala	Plitvice Lakes National Park	virgin\old-growth	n6 - Old-growth Forest	80.5
Gömöryová	2013	Slovakia	Dobročský prales	Drábsko Sihla	old-growth	n6 - Old-growth Forest	103.85
Rugani	2013	Slovenia	Gorjanci	Gorjenci massif	old-growth	n6 - Old-growth Forest	22.98
Rugani	2013	Slovenia	Kopa	Kocevski Rog massif	old-growth	n5 - Long Untouched Forest	14.05
Korňan	2013	Slovakia	Srámková	Mala Fatra Mts	primeval	n6 - Old-growth Forest	243.65
Sjögren	2012	Norway	Dividalen valley	Troms county	primeval\old-growth	n6 - Old-growth Forest	
Diaci	2012	Slovenia	Krokar	Kočevska Reka	old-growth	n6 - Old-growth Forest	74.5
Lankia	2012	Finland	Reerisuo-Losusuo Mire Reserve		old-growth	n6 - Old-growth Forest	
Kucbel	2012	Slovakia	Badín	Badinsky prales	old-growth	n6 - Old-growth Forest	30.7
Kucbel	2012	Slovakia	Havešová	Beskids Mountains	old-growth	n6 - Old-growth Forest	171.3
Kucbel	2012	Slovakia	Kyjov	Vihorlat Mountains	old-growth	n6 - Old-growth Forest	397.4
Kucbel	2012	Slovakia	Raštún	Sološnica	old-growth	n6 - Old-growth Forest	550
Kucbel	2012	Slovakia	Rožok	Mountains	old-growth	n6 - Old-growth Forest	67.2
Kucbel	2012	Slovakia	Vtáčnik		old-growth	n6 - Old-growth Forest	245.6
Ziaco	2012	Italy	Coppo del Principe	Opi	old-growth	n6 - Old-growth Forest	45
Ziaco	2012	Italy	Fonte Regna	Roccantica	Secondary old-growth	n5 - Long Untouched Forest	5
Ziaco	2012	Italy	Monte Venere	San Martino al Cimino	Secondary old-growth	n5 - Long Untouched Forest	14
Bartkowicz	2015	Poland	Gibiel	Niepołomice Forest	old-growth	n6 - Old-growth Forest	30
Bartkowicz	2015	Poland	Lipówka	Niepołomice Forest	old-growth	n6 - Old-growth Forest	25
Diaci	2011	Bosnia-Herzegovina	Igman		old-growth	n6 - Old-growth Forest	45.1
Diaci	2011	Bosnia-Herzegovina	Trstionica		old-growth	n6 - Old-growth Forest	30.5
Diaci	2011	Bosnia-Herzegovina	Pljesivica		old-growth, virgin	n6 - Old-growth Forest	38.8
Diaci	2011	Croatia	Devcica Tavani		old-growth	n6 - Old-growth Forest	100.5
Diaci	2011	Slovakia	Dobroc		old-growth	n6 - Old-growth Forest	49.8
Diaci	2011	Slovenia	Pecka		old-growth	n6 - Old-growth Forest	59.5
Diaci	2011	Slovenia	Strmec		old-growth	n6 - Old-growth Forest	15.6
Diaci	2011	Slovenia	Bukov Vrh		old-growth	n6 - Old-growth Forest	9.3
Diaci	2011	Slovenia	Lucka Bela		old-growth	n6 - Old-growth Forest	20
Diaci	2011	Slovenia	Sumik		old-growth	n6 - Old-growth Forest	19.3
Sebesta	2011	Ukraine	Maramuresh Pop-Ivan	Zakarpattya province	Primeval	n7 - Near-virgin Forest	8990
Arnan	2013	Spain		Aigüestortes i Estany de Sant Mauri	old-growth	n6 - Old-growth Forest	
Merganičová	2012	Slovakia	Babia hora	Oravská Polhora	virgin	n6 - Old-growth Forest	503.94
Aakala	2011	Finland	Lake Pyhäjärvi	Pallas-Ylläs national park	old-growth	n6 - Old-growth Forest	
Nascimbene	2010	Italy	Paneveggio	Paneveggio-Pale di San Martino Na	old-growth	n5 - Long Untouched Forest	80
Dodelin	2010	France	La Luine	Aucelon (Drôme)	old-growth	n6 - Old-growth Forest	
Dodelin	2010	France	L'Ubac de Méolans	Méolans-Revel (Alpes-de-Haute-Pr	old-growth	n6 - Old-growth Forest	

Table S3 – Results of literature review

First.Author	Year	Country	Forest_name	Location	author.definition	Naturalness.level	ha
Sjöberg	2007	Sweden	Luottâive	Norrbotten	old-growth	n6 - Old-growth Forest	
Sjöberg	2007	Sweden	Alpliden	Västerbotten	old-growth	n6 - Old-growth Forest	
Sjöberg	2007	Sweden	Stenbithöjden	Västerbotten	old-growth	n6 - Old-growth Forest	
Sjöberg	2007	Sweden	Kålhuvudet	Västernorrland	old-growth	n6 - Old-growth Forest	
Sjöberg	2007	Sweden	Jämtgaveln	Västernorrland	old-growth	n6 - Old-growth Forest	
Jabin	2007	Slovakia	Boky	Kremnické vrchy	primeval	n6 - Old-growth Forest	176
Jabin	2007	Slovakia	Pol'ana	Pol'ana Mts	primeval	n6 - Old-growth Forest	40
Jabin	2007	Slovakia	Rohy	Pol'ana Mts	primeval	n6 - Old-growth Forest	25
Ingerpuu	2007	Estonia	Urissaare	Pärnu	old-growth	n6 - Old-growth Forest	
Ingerpuu	2007	Estonia	Loodi	Viljandi	old-growth	n6 - Old-growth Forest	
Ingerpuu	2007	Estonia	Järvselja	Tartu	old-growth	n6 - Old-growth Forest	
Ingerpuu	2007	Estonia	Tipu	Kõpu, Viljandimaa	old-growth	n6 - Old-growth Forest	
Ingerpuu	2007	Estonia	Volumäe	Rägavere, Lääne-Virumaa	old-growth	n6 - Old-growth Forest	
Trotsiuk	2014	Ukraine	GR1	Gropha Landscape Reserve	primeval	n6 - Old-growth Forest	
Trotsiuk	2014	Ukraine	GR2	Gropha Landscape Reserve	primeval	n6 - Old-growth Forest	
Trotsiuk	2014	Ukraine	GR3	Gropha Landscape Reserve	primeval	n6 - Old-growth Forest	
Trotsiuk	2014	Ukraine	SY1	Syvulya mountain range	primeval	n6 - Old-growth Forest	
Trotsiuk	2014	Ukraine	SY2	Syvulya mountain range	primeval	n6 - Old-growth Forest	
Trotsiuk	2014	Ukraine	SY3	Syvulya mountain range	primeval	n6 - Old-growth Forest	
Johansson	2006	Sweden	Björnlandet	Asele SO	old-growth	n6 - Old-growth Forest	
Johansson	2006	Sweden	Trolltjärn	Ornsköldsvik NV	old-growth	n6 - Old-growth Forest	
Johansson	2006	Sweden	Gammtratten A	Gammtratten reserve	old-growth	n6 - Old-growth Forest	
Johansson	2006	Sweden	Gammtratten B	Gammtratten reserve	old-growth	n6 - Old-growth Forest	
Rozas	2006	Spain	Caviedes forest	Oyambre Natural Park	old-growth	n5 - Long Untouched Forest	110
Esseen	2006	Sweden	Granladet Reserve	Norrbotten	old-growth	n7 - Near-virgin Forest	28400
Westphal	2006	Albania	Mirdita		virgin	n6 - Old-growth Forest	5
Westphal	2006	Albania	Puka		virgin	n6 - Old-growth Forest	3.6
Westphal	2006	Albania	Rrajca	Elbasan, Librazhd district	old-growth + significant virgin p	n7 - Near-virgin Forest	2129.45
Westphal	2006	Ukraine	Borzhava		virgin	n6 - Old-growth Forest	
Lohmus	2005	Estonia	Alam-Pedja Nature Reserve		old-growth	n6 - Old-growth Forest	
Richard	2005	France	Fango Valley	Corsica	old-growth	n6 - Old-growth Forest	15
Komonen	2005	Finland	Autiovaara	Patvinsuo National Park	old-growth	n6 - Old-growth Forest	
Lundqvist	2007	Sweden	Kirjesålandet	Sakkats mountain	virgin	n6 - Old-growth Forest	300
Laaka-Lindberg	2005	Finland	Katinen Nature Reserve	Lammi district	old-growth	n6 - Old-growth Forest	
Rouvinen	2005	Finland	Pönttövaara	North Carelia	old-growth	n5 - Long Untouched Forest	135
Kornan	2004	Slovakia	Sútovská Dolina National Nature Reserve	Malá Fatra Mts	natural	n6 - Old-growth Forest	526.65
Leuschner	2004	Germany	Göttinger Wald	Gleichen	old-growth	n5 - Long Untouched Forest	
Leuschner	2004	Germany	Kyffhäuser		old-growth	n5 - Long Untouched Forest	
Leuschner	2004	Germany	Ziegelrodaer Forst	Querfurt	old-growth	n5 - Long Untouched Forest	
Leuschner	2004	Germany	Solling		old-growth	n5 - Long Untouched Forest	
Leuschner	2004	Germany	Lüneburger Heide		old-growth	n5 - Long Untouched Forest	
Kuuluvainen	2003	Finland	Nuijakorpi forest protection area	Hyytiälä forestry field station	old-growth	n6 - Old-growth Forest	
Svenning	2001	Sweden	Västra Kvarken	Gulf of Bothnia	old-growth	n6 - Old-growth Forest	1

Table S3 – Results of literature review

First.Author	Year	Country	Forest_name	Location	author.definition	Naturalness.level	ha
Kaiser	2001	Germany		Seybothenreuth	old-growth	n5 - Long Untouched Forest	
Kaiser	2001	Germany		Betzenstein	old-growth	n5 - Long Untouched Forest	
Jaworski	2002	Poland	Hylaty (Jawornik)	Bieszczadzki National Park	primeval	n6 - Old-growth Forest	582
Jaworski	2002	Poland	Tworylczyk	Bieszczadzki National Park	primeval	n6 - Old-growth Forest	148
Samonil	2015	Czech Republic	Razula	Javorniky Mountains	virgin	n5 - Long Untouched Forest	21
Jankovsky	2004	Czech Republic	Certův mlýn	Beskydy mountains	virgin	n5 - Long Untouched Forest	
Jankovsky	2004	Czech Republic	Kněhyně	Beskydy mountains	virgin	n5 - Long Untouched Forest	
Topoliantz	2000	France	La Tillaie	Fontainebleau	old-growth	n5 - Long Untouched Forest	33.74
Ojala	2000	Finland	Jaurakkavaara	Puolanka	old-growth	n6 - Old-growth Forest	400
Ojala	2000	Finland	Olvassuo	Pudasjärvi	old-growth	n6 - Old-growth Forest	442
Ojala	2000	Finland	Siikavaara west	Puolanka	old-growth	n6 - Old-growth Forest	2200
Ojala	2000	Finland	Lososuo	Suomussalmi	old-growth	n6 - Old-growth Forest	116
Ojala	2000	Finland	Juortaansalo	Kuhmo	old-growth	n6 - Old-growth Forest	990
Ojala	2000	Finland	Murronaho	Suomussalmi	old-growth	n6 - Old-growth Forest	166
Ojala	2000	Finland	Louhenvaara	Suomussalmi	old-growth	n6 - Old-growth Forest	166
Maycock	2000	Poland	Babia Gora	Czarny szlak pieszy	old-growth	n6 - Old-growth Forest	
Maycock	2000	Poland	Poreba Wielka-Koninki		old-growth	n6 - Old-growth Forest	
Maycock	2000	Poland	Turbacz Creek Valley	Konina	old-growth	n6 - Old-growth Forest	
Maycock	2000	Poland	Kostrza Mt.	Wilkowisko	old-growth	n6 - Old-growth Forest	
Maycock	2000	Poland	Klodne nad Dunajcer Reserve	Krościenko nad Dunajcem	old-growth	n6 - Old-growth Forest	
Maycock	2000	Poland	Baniska Reserve	Rytro	old-growth	n6 - Old-growth Forest	
Maycock	2000	Poland	Labowiec Reserve	Gorczański Park Narodowy	old-growth	n6 - Old-growth Forest	
Maycock	2000	Slovakia	Hroncokovy grun	Cierny Balog	old-growth	n6 - Old-growth Forest	55.2
Maycock	2000	Ukraine	Mala Uholka		old-growth	n6 - Old-growth Forest	
Maycock	2000	Ukraine	Velyka Uholka		old-growth	n6 - Old-growth Forest	
Maycock	2000	Ukraine	Shyrokoluzhankyi Massive		old-growth	n6 - Old-growth Forest	
Maycock	2000	Ukraine	Ivankyvci		old-growth	n6 - Old-growth Forest	
Ostojic	2008	Serbia	Danilova Kosa	Brštica	virgin	n6 - Old-growth Forest	6
Ostojic	2008	Serbia	Feljeshana	Jelovac	virgin	n6 - Old-growth Forest	15.28
Ostojic	2008	Serbia	Kukavica	Rdovo	virgin	n6 - Old-growth Forest	75.76
Ostojic	2008	Serbia	Vinatovača	Strmosten	virgin	n6 - Old-growth Forest	37.43
Ostojic	2008	Serbia	Golema Reka	Stara planina Nature park	virgin	n6 - Old-growth Forest	34.6
Ostojic	2008	Serbia	Busovata	Zagubica	virgin	n6 - Old-growth Forest	15.86
Lahde	2002	Finland		Rautavaara	old-growth	n5 - Long Untouched Forest	
Biris		Romania	Cosava Mica	Semenic Mountain	n10 - Primeval Forest	n6 - Old-growth Forest	
Standovár		Hungary	Kékes Forest Reserve	Kékes, Mátra Mts	Old-growth Forest	n6 - Old-growth Forest	55
Vrska	2012	Czech Republic	Boubín	Bohemian Forest Mountains	n9 - Virgin Forest	n6 - Old-growth Forest	46
Panajiotidis	2001	Greece	Mavrologos	Prionia, Mt Olympus	n7 - Near-virgin Forest	n6 - Old-growth Forest	
Panajiotidis	2001	Greece	Dasos 1000 dendron Mourion	Mouries, Kilkis	n10 - Primeval Forest	n6 - Old-growth Forest	
Panajiotidis	2001	Greece	Dasos Apollonias	Apollonia, Lake Volvi	n10 - Primeval Forest	n5 - Long Untouched Forest	
Panajiotidis	2001	Greece	Baruga (Katafyki) Natural Monument	Grammos mountain, Kastoria Prefec	n5 - Long Untouched Forest	n5 - Long Untouched Forest	
Tsiripidis	2003	Greece	Frakto	Paranesti	n6 - Old-growth Forest	n7 - Near-virgin Forest	
Vandekerkhove	2001	Belgium	Sonian Forest, core zone of the Forest Res	Groenendaal	n6 - Old-growth Forest	n5 - Long Untouched Forest	11

Table S3 – Results of literature review

First.Author	Year	Country	Forest_name	Location	author.definition	Naturalness.level	ha
Kirchmeir	2016	Albania	Lumi i gashit	Kukes, Tropojë district	old-growth + fragments of virgir	n7 - Near-virgin Forest	1261.52
Kirchmeir	2016	Albania	Rrajca	Elbasan, Librazhd district	old-growth + significant virgin p	n7 - Near-virgin Forest	2129.45
Kirchmeir	2016	Austria	Dürrenstein	Province of Lower Austria	old-growth + significant virgin p	n7 - Near-virgin Forest	1867.45
Kirchmeir	2016	Austria	Kalkalpen -Hintergebirge	Province of Upper Austria	old-growth + fragments of virgir	n6 - Old-growth Forest	2946.2
Kirchmeir	2016	Austria	Kalkalpen -Bodinggraben	Province of Upper Austria	old-growth + fragments of virgir	n6 - Old-growth Forest	890.89
Kirchmeir	2016	Austria	Kalkalpen - Urlach	Province of Upper Austria	old-growth + fragments of virgir	n6 - Old-growth Forest	264.82
Kirchmeir	2016	Austria	Kalkalpen - WilderGraben	Province of Upper Austria	old-growth + fragments of virgir	n6 - Old-growth Forest	1149.75
Kirchmeir	2016	Belgium	Sonian Forest - Forest Reserve "JosephZ\	Flanders	old-growth	n5 - Long Untouched Forest	187.34
Kirchmeir	2016	Belgium	Sonian Forest – Grippensdelle A	Brussels Capital Region	old-growth	n5 - Long Untouched Forest	24.11
Kirchmeir	2016	Belgium	Sonian Forest - Grippensdelle B	Brussels Capital Region	old-growth	n5 - Long Untouched Forest	37.38
Kirchmeir	2016	Belgium	Sonian Forest - Réserve forestière du Tict	Wallonia	old-growth	n5 - Long Untouched Forest	13.98
Kirchmeir	2016	Belgium	Sonian Forest - Réserve forestière du Tict	Wallonia	old-growth	n5 - Long Untouched Forest	6.5
Kirchmeir	2016	Bulgaria	Boatin Reserve	Lovech	majority virgin	n7 - Near-virgin Forest	1226.88
Kirchmeir	2016	Bulgaria	Tsarichina Reserve	Lovech	majority virgin	n7 - Near-virgin Forest	1485.81
Kirchmeir	2016	Bulgaria	Kozya stena Reserve	Lovech	majority virgin	n7 - Near-virgin Forest	644.43
Kirchmeir	2016	Bulgaria	Steneto Reserve	Lovech, Plovdiv	majority virgin	n7 - Near-virgin Forest	2466.1
Kirchmeir	2016	Bulgaria	Stara reka Reserve	Plovdiv	majority virgin	n7 - Near-virgin Forest	591.2
Kirchmeir	2016	Bulgaria	Dzhendema Reserve	Plovdiv, Stara Zagora	majority virgin	n7 - Near-virgin Forest	1774.12
Kirchmeir	2016	Bulgaria	Severen Dzhendem Reserve	Lovech	majority virgin	n7 - Near-virgin Forest	926.37
Kirchmeir	2016	Bulgaria	Peeshti skali Reserve	Lovech, Gabrovo	majority virgin	n7 - Near-virgin Forest	1049.1
Kirchmeir	2016	Bulgaria	Sokolna Reserve	Stara Zagora	majority virgin	n7 - Near-virgin Forest	824.9
Kirchmeir	2016	Croatia	Hajdučki i Rožanski kukovi	Ličko-Senjska County, Velebit Mount	majority virgin	n7 - Near-virgin Forest	1289.11
Kirchmeir	2016	Croatia	Paklenica National Park - Suva draga-Klim	Dinaric region, or Dinaric Alpes	majority virgin	n7 - Near-virgin Forest	1241.04
Kirchmeir	2016	Croatia	Paklenica National Park - Oglavinovac-Jav	Dinaric region, or Dinaric Alpes	majority virgin	n7 - Near-virgin Forest	790.74
Kirchmeir	2016	Italy	Valle Cervara	Abruzzo, Lazio & Molise NP	old-growth + significant virgin p	n6 - Old-growth Forest	119.7
Kirchmeir	2016	Italy	Selva Moricento	Abruzzo, Lazio & Molise NP	old-growth + significant virgin p	n5 - Long Untouched Forest	192.7
Kirchmeir	2016	Italy	Coppo del Morto	Abruzzo, Lazio & Molise NP	old-growth + significant virgin p	n6 - Old-growth Forest	104.71
Kirchmeir	2016	Italy	Coppo del Principe	Abruzzo, Lazio & Molise NP	old-growth + significant virgin p	n5 - Long Untouched Forest	194.49
Kirchmeir	2016	Italy	Val Fondillo	Abruzzo, Lazio & Molise NP	old-growth + significant virgin p	n5 - Long Untouched Forest	325.03
Kirchmeir	2016	Italy	Cozzo Ferriero	Region Basilicata - Province of Pote	old-growth	n5 - Long Untouched Forest	95.74
Kirchmeir	2016	Italy	Foresta Umbra	Region Puglia - Province of Foggia	old-growth	n5 - Long Untouched Forest	182.23
Kirchmeir	2016	Italy	Monte Cimino	Region Lazio - Province of Viterbo	old-growth	n5 - Long Untouched Forest	57.54
Kirchmeir	2016	Italy	Monte Raschio	Region Lazio - Province of Viterbo	old-growth	n5 - Long Untouched Forest	73.73
Kirchmeir	2016	Italy	Sasso Fratino	Region Emilia - Romagna - Provinc	old-growth	n6 - Old-growth Forest	781.43
Kirchmeir	2016	Poland	Border Ridge and Upper Solinka Valley	Bieszczadzki National Park	majority virgin	n7 - Near-virgin Forest	1482.18
Kirchmeir	2016	Poland	Polonia Wetlińska and Smerek	Bieszczadzki National Park	majority virgin	n7 - Near-virgin Forest	1049.53
Kirchmeir	2016	Poland	Stream Terebowiec valley	Bieszczadzki National Park	majority virgin	n7 - Near-virgin Forest	200.99
Kirchmeir	2016	Poland	Stream Wolosatka valley	Bieszczadzki National Park	majority virgin	n7 - Near-virgin Forest	574.33
Kirchmeir	2016	Romania	Cheile Nerei-Beușnița	Caraș Severin County	majority virgin	n7 - Near-virgin Forest	4292.27
Kirchmeir	2016	Romania	Codrul secular Șinca	Brașov County	majority virgin	n7 - Near-virgin Forest	338.24
Kirchmeir	2016	Romania	Codrul Secular Slătioara	Suceava County	majority virgin	n7 - Near-virgin Forest	609.12
Kirchmeir	2016	Romania	Cozia - Masivul Cozia	Vâlcea County	majority virgin	n7 - Near-virgin Forest	2285.86
Kirchmeir	2016	Romania	Cozia - Lotrisor	Vâlcea County	majority virgin	n7 - Near-virgin Forest	1103.3

Table S3 – Results of literature review

First.Author	Year	Country	Forest_name	Location	author.definition	Naturalness.level	ha
Kirchmeir	2016	Romania	Domogled - Valea Cernei- Domogled-Cor	Caraș Severin County	majority virgin	n7 - Near-virgin Forest	5110.63
Kirchmeir	2016	Romania	Domogled - Valea Cernei- Iauna Craiovei	Caraș Severin County and Mehedinț	majority virgin	n7 - Near-virgin Forest	3517.36
Kirchmeir	2016	Romania	Domogled - Valea Cernei- Ciucevele Cern	Caraș Severin County and Gorj Cou	majority virgin	n7 - Near-virgin Forest	1104.27
Kirchmeir	2016	Romania	Groșii Țibleșului - Izvorul Șurii	Maramureș County	majority virgin	n7 - Near-virgin Forest	210.55
Kirchmeir	2016	Romania	Groșii Țibleșului - Preluci	Maramureș County	majority virgin	n7 - Near-virgin Forest	135.82
Kirchmeir	2016	Romania	Izvoarele Nerei	Caraș Severin County	majority virgin	n7 - Near-virgin Forest	4677.21
Kirchmeir	2016	Romania	Strîmbu Băiuț	Maramureș County	majority virgin	n7 - Near-virgin Forest	598.14
Kirchmeir	2016	Slovenia	Krokar	Municipality Kočevje	majority virgin	n7 - Near-virgin Forest	74.5
Kirchmeir	2016	Slovenia	Snežnik-Zdrocle	Municipality Ilirska Bistrica and Mun	old-growth + fragments of virgin	n5 - Long Untouched Forest	720.24
Kirchmeir	2016	Spain	Hayedos de Ayllón -Tejera Negra	Autonomous Community of Castilla-l	old-growth + fragments of virgin	n5 - Long Untouched Forest	255.52
Kirchmeir	2016	Spain	Hayedos de Ayllón -Montejo	Providence of Guadaljara, region of	old-growth + fragments of virgin	n5 - Long Untouched Forest	71.79
Kirchmeir	2016	Spain	Hayedos de Navarra -Lizardoia	Ochagavia,salazar valley	old-growth + significant virgin p	n5 - Long Untouched Forest	63.97
Kirchmeir	2016	Spain	Hayedos de Navarra -Aztaparreta	Isaba, Roncal valley	old-growth + significant virgin p	n6 - Old-growth Forest	171.06
Kirchmeir	2016	Spain	Hayedos de Picos de Europa - Cuesta Fría	Autonomous Community of Castilla y	old-growth + significant virgin p	n6 - Old-growth Forest	213.65
Kirchmeir	2016	Spain	Hayedos de Picos de Europa - Canal de As	Autonomous Community of Castilla y	old-growth + significant virgin p	n6 - Old-growth Forest	109.58
Kirchmeir	2016	Ukraine	Gorgany	Ivano-Frankivsk region, Nadvirna dis	majority virgin	n7 - Near-virgin Forest	753.48
Kirchmeir	2016	Ukraine	Roztochya	Lviv region	old-growth + significant virgin p	n6 - Old-growth Forest	384.81
Kirchmeir	2016	Ukraine	Satanivska Dacha	Khmelnytska region, Horodok distric	old-growth + fragments of virgin	n5 - Long Untouched Forest	212.01
Kirchmeir	2016	Ukraine	Synevyr - Darvaika	Zakarpattia region, Mizhgirja	majority virgin	n7 - Near-virgin Forest	1588.46
Kirchmeir	2016	Ukraine	Synevyr - Kvasovets	Zakarpattia region, Mizhgirja	majority virgin	n6 - Old-growth Forest	561.62
Kirchmeir	2016	Ukraine	Synevyr - Strymba	Zakarpattia region, Mizhgirja	majority virgin	n6 - Old-growth Forest	260.65
Kirchmeir	2016	Ukraine	Synevyr - Vilshany	Zakarpattia region, Mizhgirja	majority virgin	n6 - Old-growth Forest	454.31
Kirchmeir	2016	Ukraine	Zacharovanyi Krai -Irshavka	Zakarpattia region, Irshava	majority virgin	n6 - Old-growth Forest	93.97
Kirchmeir	2016	Ukraine	Zacharovanyi Krai -Velykyi Dil	Zakarpattia region, Irshava	majority virgin	n7 - Near-virgin Forest	1164.16
Diaci	1999	Croatia	Velika Plješivica - Drenovača		virgin	n6 - Old-growth Forest	156.84
Jaworski	2001	Poland	Czarna Hala	Babia Gora National Park	Primeval	n6 - Old-growth Forest	
Jaworski	2001	Poland	Dolny Płay	Babia Gora National Park	Primeval	n6 - Old-growth Forest	
Jaworski	2001	Poland	Jałowiecki Potok	Babia Gora National Park	Primeval	n6 - Old-growth Forest	
Jaworski	2001	Poland	Pod Sokolica	Babia Gora National Park	Primeval	n6 - Old-growth Forest	
Panayotov	2011	Bulgaria	Parangalitsa	Bistritsa valley, Rila National Park	old-growth	n6 - Old-growth Forest	250
Tinya	2016	Hungary	Szalafoi Oserdo Forest Reserve	Orség National Park	old-growth	n5 - Long Untouched Forest	89.5
Mazziotta	2016	Denmark	Tofte Skov	Lille Vildmose reserve	old-growth	n6 - Old-growth Forest	234.8
Mazziotta	2016	Denmark	Høstemark Skov	Lille Vildmose reserve	old-growth	n6 - Old-growth Forest	74.5
Janík	2016	Czech Republic	Ranšpurk	South Moravian alluvium	old-growth	n5 - Long Untouched Forest	19
Janík	2011	Czech Republic	Cahnov–Soutok	South Moravian alluvium	old-growth	n5 - Long Untouched Forest	13
Tiscar	2016	Spain	Poyo de Santo Domingo	Cazorla, Segura and Las Villas Natu	old-growth	n5 - Long Untouched Forest	45
Granata	2016	Italy	Bosco Siro Negri	Zerbolò	old-growth	n5 - Long Untouched Forest	9
Pittar	2008	Slovakia	Nefcerská dolina	Tatra National Park	virgin	n6 - Old-growth Forest	
Vrska	2009	Czech Republic	Mionší	Beskydy mountains	old-growth	n5 - Long Untouched Forest	169
Janik	2016	Czech Republic	Žákova hora	Bohemian-Moravian Highland	old-growth	n5 - Long Untouched Forest	17
Král	2016	Czech Republic	Salajka	Beskydy mountains	old-growth	n5 - Long Untouched Forest	21
Vašíčková	2016	Czech Republic	Polom	Zelezné Mountains	old-growth	n5 - Long Untouched Forest	18

Table S3 – Results of literature review

First.Author	Year	Country	Forest_name	Location	author.definition	Naturalness.level	ha
Vašíčková	2016	Czech Republic	Stožec	Bohemian Forest Mountains	old-growth	n6 - Old-growth Forest	16
Vrska	2001	Czech Republic	Milešice	Bohemian Forest Mountains	old-growth	n5 - Long Untouched Forest	
Vrska	2017	Czech Republic	NP Podyjí - Lipina	South Moravian province	old-growth	n5 - Long Untouched Forest	
Matula	2015	Czech Republic	NP Podyjí - Zlámaná skála	South Moravian province	old-growth	n5 - Long Untouched Forest	

Table S4 – Summary of primary forest extent by country

Table S4 – Summary of primary forest extent by country. For each country we reported the total area of primary forest, the fraction of country area covered by primary forest, the percentage of primary forest under legal protection, and under strict protection (IUCN category I), the number of mapped forest remnants and their median extent.

	Primary forest (1,000 ha)	Fraction of country covered by primary forests (%)	Protected (%)	Protected under IUCN regime I (1,000 ha)	Num. remnants	Median extent (ha)
Albania	3.64	0.13%	93.1%	34.6%	6	121
Austria	7.13	0.08%	100.0%	10.9%	6	1020
Belarus	0.06	0.00%	98.4%	96.7%	-	-
Belgium	0.27	0.01%	100.0%	0.0%	5	24
Bosnia and Herzegovina	1.75	0.03%	91.5%	5.6%	6	55
Bulgaria	55.71	0.50%	99.2%	75.8%	219	50
Croatia	9.83	0.17%	100.0%	24.7%	58	58
Cyprus	-	-	-	-	-	-
Czech Republic	8.87	0.11%	98.5%	6.7%	115	22
Denmark	1.69	0.04%	100.0%	19.8%	24	24
Estonia	0.05	0.00%	95.7%	0.0%	29	2
Finland	985.95	2.92%	98.9%	55.2%	1442	20
France	5.50	0.01%	100.0%	0.6%	57	4
Germany	5.93	0.02%	97.8%	0.0%	43	49
Greece	1.79	0.01%	100.0%	42.9%	26	11
Hungary	0.28	0.00%	100.0%	0.0%	8	28
Ireland	-	-	-	-	-	-
Italy	5.56	0.02%	99.9%	35.5%	79	32
Latvia	-	-	-	-	-	-
Lithuania	32.55	0.50%	100.0%	75.2%	23	283
Luxembourg	-	-	-	-	-	-
Macedonia	0.83	0.03%	100.0%	0.0%	6	105
Malta	-	-	-	-	-	-
Moldova	-	-	-	-	-	-
Montenegro	2.83	0.20%	100.0%	0.0%	1	2834
Netherlands	0.08	0.00%	98.8%	0.0%	3	25
Norway	105.83	0.33%	5.6%	3.5%	62	398
Poland	21.27	0.07%	100.0%	0.2%	71	57
Portugal	16.21	0.18%	93.3%	24.8%	216	6
Romania	51.67	0.22%	94.9%	0.1%	161	109
Serbia	0.21	0.00%	71.2%	11.2%	7	16
Slovakia	11.02	0.22%	96.7%	56.2%	280	16
Slovenia	9.58	0.47%	98.0%	27.0%	168	16
Spain	6.80	0.01%	100.0%	92.3%	9	110
Sweden	30.08	0.07%	97.7%	0.1%	56	6
Switzerland	21.54	0.52%	87.8%	76.6%	16	58
Ukraine	70.11	0.12%	44.4%	26.7%	590	26
United Kingdom	0.10	0.00%	65.0%	0.0%	2	50
Total	1474.70	0.25%	89.3%	45.9%	3794	24

Table S5 – Summary of primary forest extent by biogeographical region

Table S5 – Summary of primary forest extent by biogeographical region. For each region we reported the total area of primary forest, the fraction of country area covered by primary forest, the percentage of primary forest under legal protection, and under strict protection (IUCN category I), the number of mapped forest remnants and their median extent.

	Primary forest (1,000 ha)	Fraction of region covered by primary forests (%)	Protected (%)	Protected under IUCN regime I (1,000 ha)	Num. remnants	Median extent (ha)
Alpine	389.89	0.58%	68.9%	45.2%	1473	31
Atlantic	15.28	0.02%	66.7%	50.4%	45	61
Black sea	6.84	0.61%	100.0%	91.9%	17	54
Boreal	977.51	0.99%	96.8%	48.6%	1556	19
Continental	61.08	0.03%	96.7%	9.4%	355	32
Macaronesia	15.10	1.47%	93.3%	26.7%	165	6
Mediterranean	8.46	0.01%	99.0%	17.4%	163	14
Pannonian	0.53	0.00%	100.0%	0.0%	16	19
Global	1474.70	0.25%	89.3%	45.9%	3794	24

Table S6 – Summary of BRT accuracy and precision for increasing likelihood thresholds

Table S6 – Comparison of accuracy, true and false positive rates, true and false negative rates, and precision when different thresholds were used for discriminating between predicted primary forest occurrence vs. absence. TPR: True Positive rate; FPR: False Positive Rate; TNR: True Negative Rate; FNR: False Negative Rate. Accuracy is defined as the square root of the product between TPR and TNR. Precision is calculated as the ratio between true positives and the sum of false positives and true positives.

Percentile	Likelihood Threshold	TPR	FPR	TNR	FNR	Accuracy	Precision
0	0.009	0.991	0.997	0.003	0.009	0.056	0.498
5	0.057	0.986	0.992	0.008	0.014	0.088	0.498
10	0.076	0.983	0.98	0.02	0.017	0.141	0.501
15	0.095	0.978	0.964	0.036	0.022	0.187	0.504
20	0.115	0.975	0.952	0.048	0.025	0.217	0.506
25	0.136	0.973	0.941	0.059	0.027	0.24	0.509
30	0.159	0.97	0.916	0.084	0.03	0.286	0.514
35	0.182	0.953	0.897	0.103	0.047	0.314	0.515
40	0.207	0.93	0.861	0.139	0.07	0.36	0.519
45	0.234	0.914	0.827	0.173	0.086	0.398	0.525
50	0.263	0.908	0.798	0.202	0.092	0.428	0.532
55	0.296	0.891	0.761	0.239	0.109	0.461	0.539
60	0.332	0.873	0.72	0.28	0.127	0.494	0.548
65	0.373	0.85	0.677	0.323	0.15	0.524	0.557
70	0.42	0.834	0.622	0.378	0.166	0.562	0.573
75	0.473	0.794	0.547	0.453	0.206	0.6	0.592
80	0.536	0.733	0.467	0.533	0.267	0.625	0.611
85	0.61	0.662	0.388	0.612	0.338	0.637	0.631
90	**0.703**	**0.575**	**0.288**	**0.712**	**0.425**	**0.64**	**0.667**
95	0.818	0.412	0.148	0.852	0.588	0.593	0.735
100	0.992	0	0	1	1	0	NA

Figure S1 – Fraction of the study area were systematic inventories of primary forests were performed (bias mask)

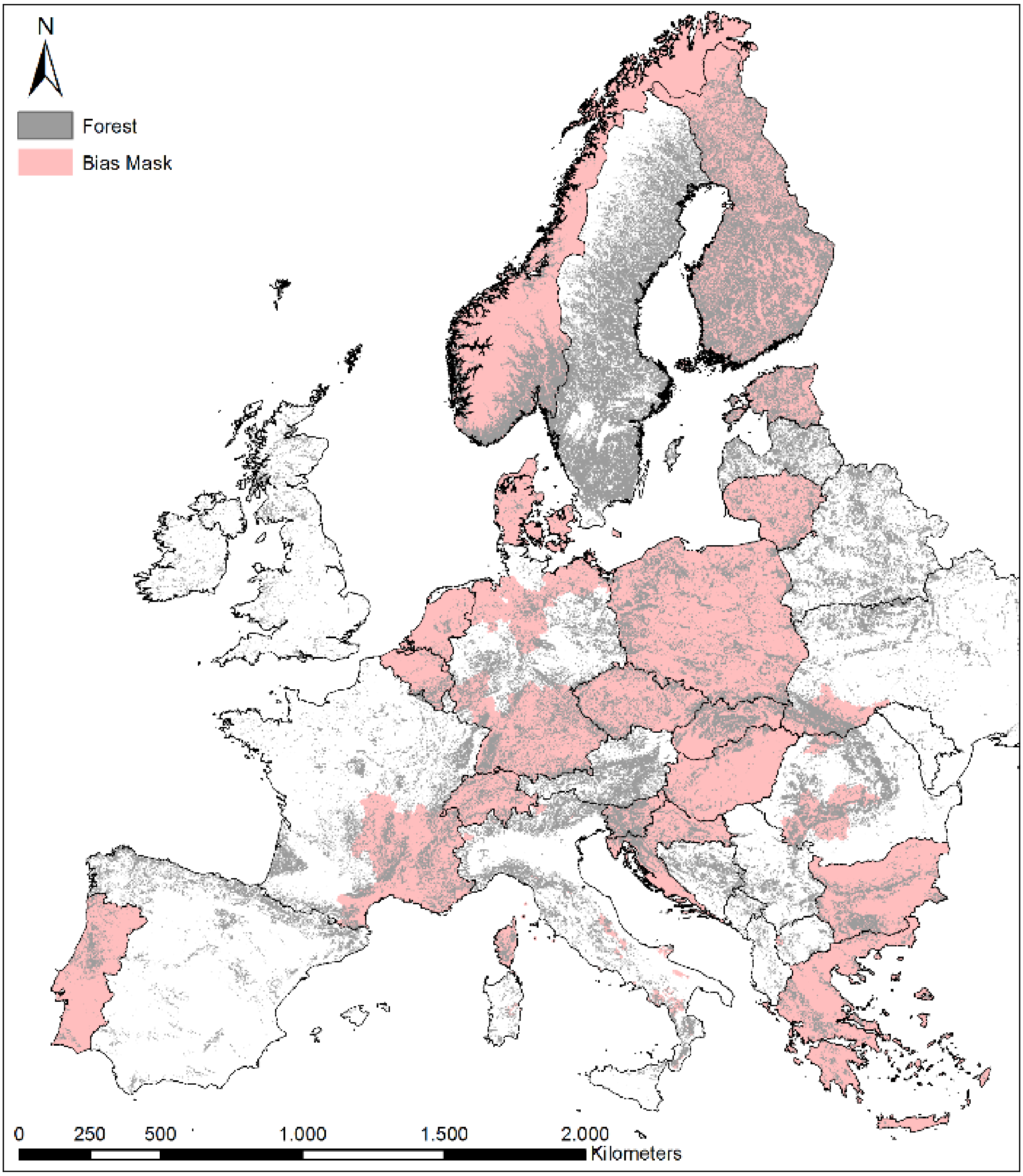

Figure S1 – European forest area (grey) at a 1x1 km resolution and bias mask (pink) used for selecting the background points used to train the Boosted Regression Tree model. The pink areabias mask represents the fraction of the study area were systematic inventories of primary forests were performed. More than 96% of the primary forests occurred within the mask. The forest mask was derived from Hengeveld et al. (2015)

Figure S2 – Barplot of primary forest area per forest type and naturalness level

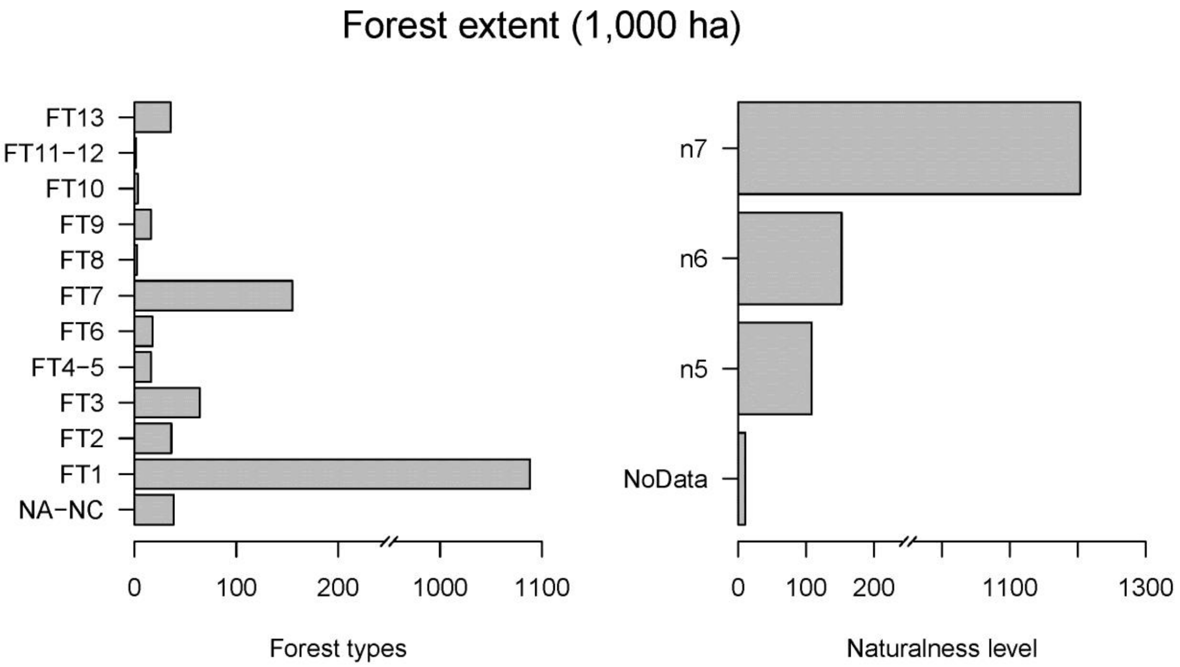

Figure S2 – Extent of primary forest in the compiled dataset, according to Forest types (EEA, 2006) and naturalness levels (Buchwald, 2005). Forest types follow (EEA, 2006): FT1-Boreal forest, FT2 - Hemiboreal and nemoral coniferous-mixed forest, FT3 - Alpine coniferous, FT4-5 - Mesophytic deciduous and acidophilous forest, FT6 – Beech forest, FT7 - Mountainous beech forest, FT8 - Thermophilous deciduous forest, FT9 - Broadleaved evergreen forest; FT10 - Coniferous Mediterranean forest; FT12 – Floodplain forest, FT13 - Non-riverine alder, birch or aspen, NA-NC - NoData/Unclassified. Naturalness levels: n7 - Near-virgin forest, n6 – Old-growth forest, n5 – Long-undisturbed forest.

Figure S3 – Barplot of primary forest patches (counts) per forest type and naturalness level

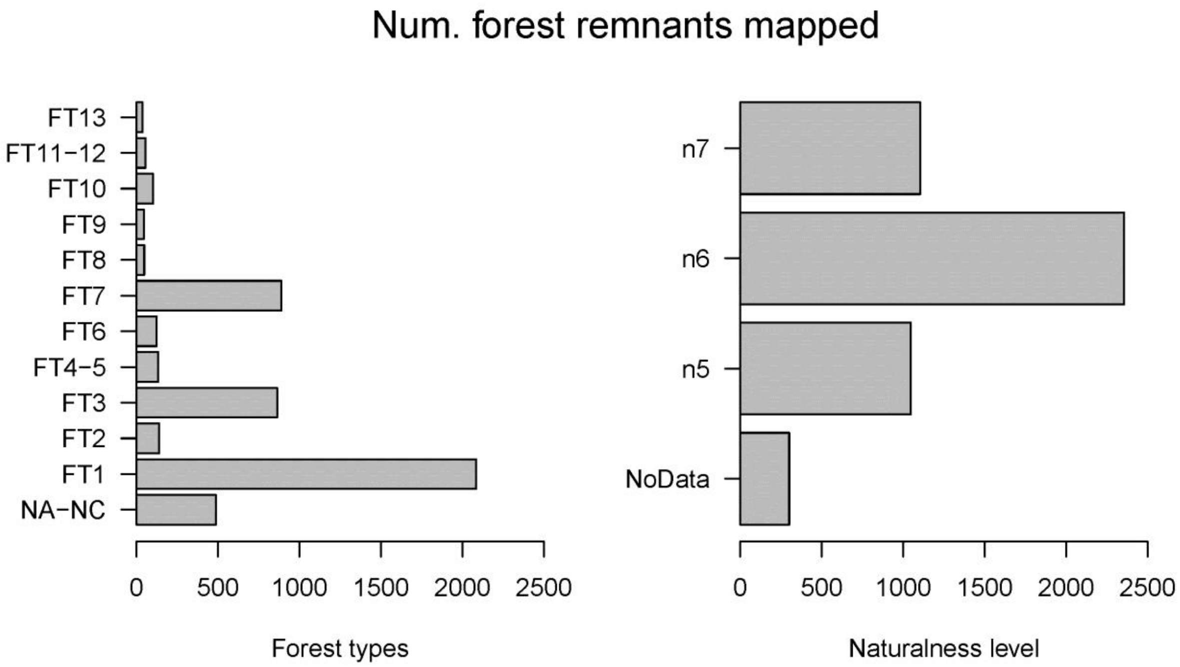

Figure S3 – Number of primary forest remnants mapped across Forest types (EEA, 2006) and naturalness levels (Buchwald, 2005). Forest types follow Forest types: FT1- Boreal forest, FT2 - Hemiboreal and nemoral coniferous-mixed forest, FT3 - Alpine coniferous, FT4-5 - Mesophytic deciduous and acidophilous forest, FT6 – Beech forest, FT7 - Mountainous beech forest, FT8 - Thermophilous deciduous forest, FT9 - Broadleaved evergreen forest; FT10 - Coniferous Mediterranean forest; FT12 – Floodplain forest, FT13 - Non-riverine alder, birch or aspen, NA-NC - NoData/Unclassified. Naturalness levels: n7 - Near-virgin forest, n6 – Old-growth forest, n5 – Long-undisturbed forest.

Figure S4 – Precision and Accuracy of BRT model for increasing thresholds of relative likelihoods

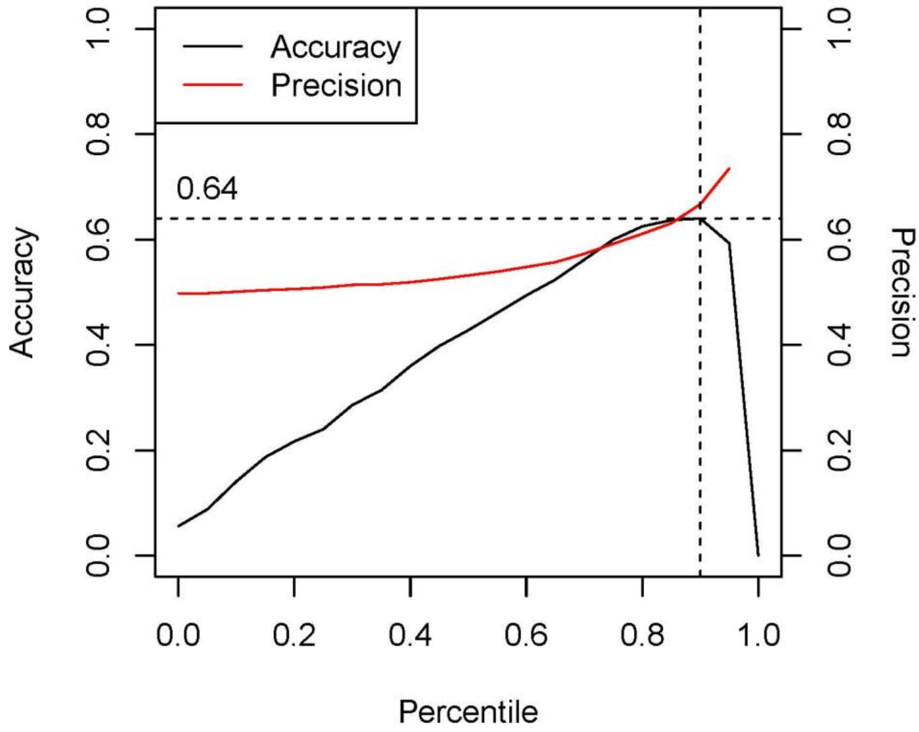

Figure S4 – Graph plotting BRT model accuracy and precision when different thresholds were considered for discriminating between predicted primary forest occurrence vs. absence.

Figure S5 – Map of congruency between predicted (top 10th percentile) and observed primary forests

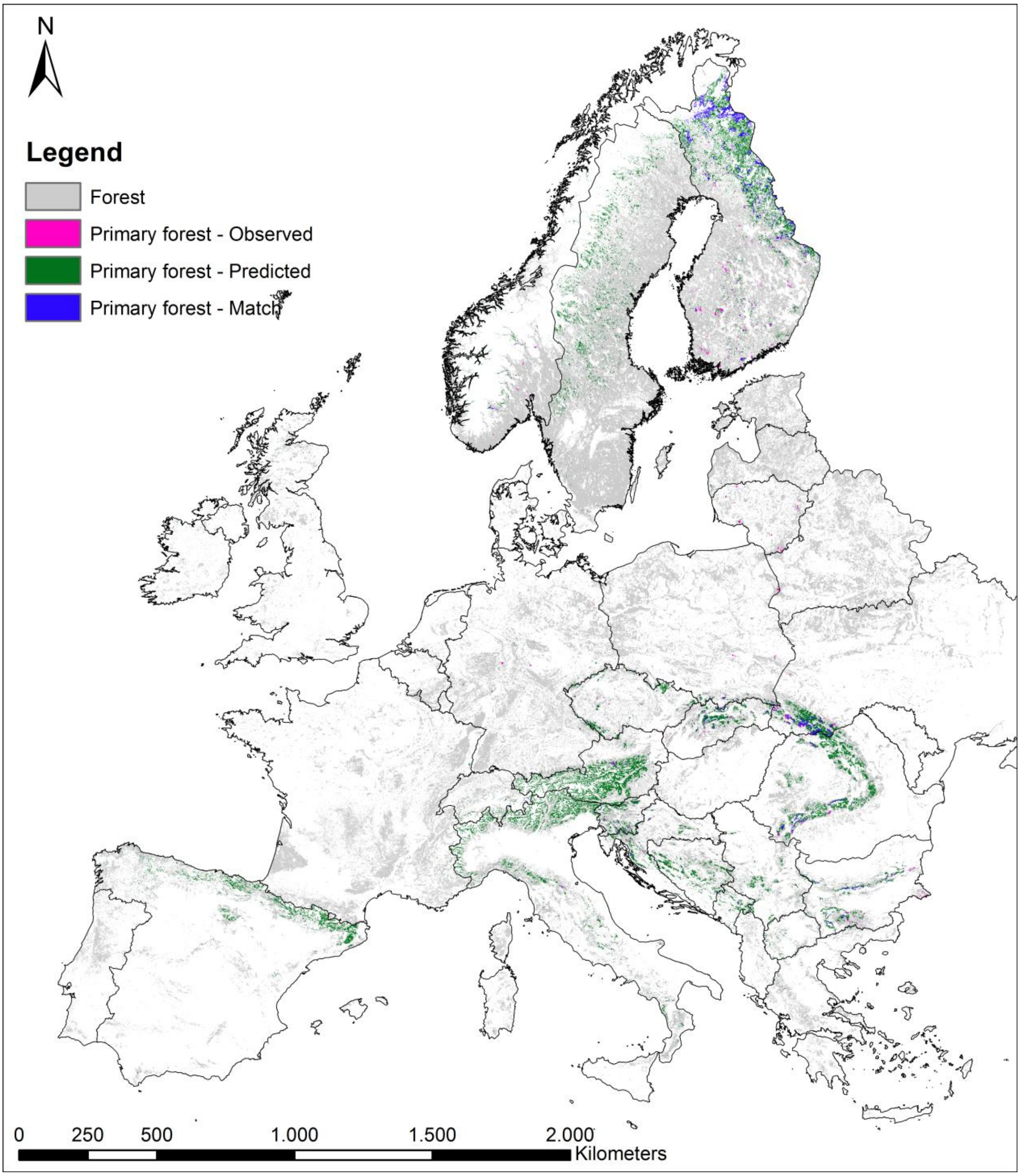

Figure S5 - Map of congruency between predicted (top 10th percentile) and observed primary forests.

Figure S6 – Map of the protections status of the areas predicted to host primary forests

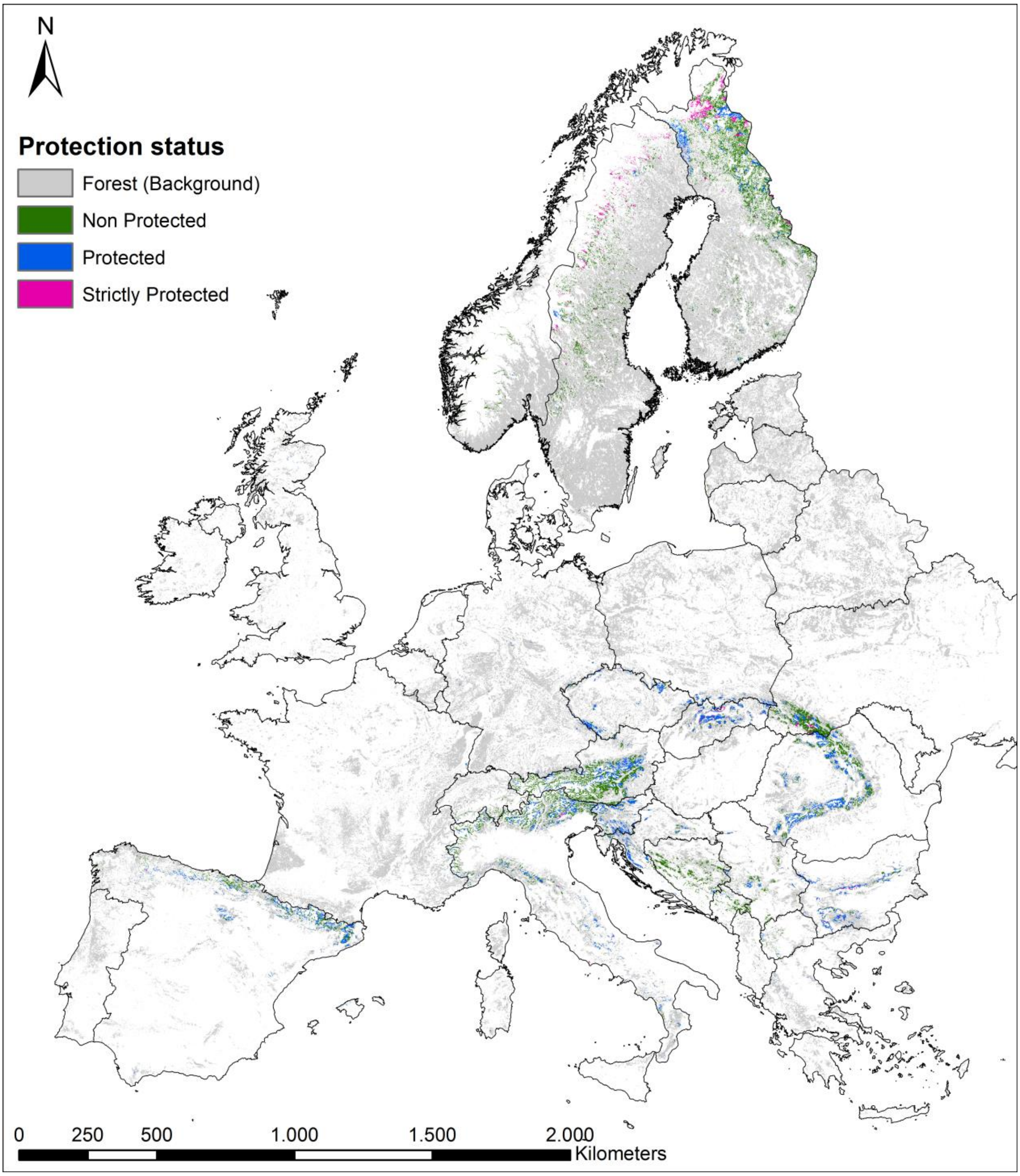

Figure S6 –Share of predicted (top 10^th^ percentile) primary forests being currently under protection and strict (IUCN level I) protection.

Cited References

Blasi, C., Burrascano, S., Maturani, A. & Sabatini, F.M. (2010) *Old-growth forests in Italy*. Palombi Editori, Rome, Italy.

Bottero, A., Garbarino, M., Dukic, V., Govedar, Z., Lingua, E., Nagel, T.A. & Motta, R. (2011) Gap-phase dynamics in the old-growth forest of Lom, Bosnia and Herzegovina. *Silva Fennica*, **45**, 875-887.

Buchwald, E. (2005) A hierarchical terminology for more or less natural forests in relation to sustainable management and biodiversity conservation. *Proceedings: Third expert meeting on harmonizing forest-related definitions for use by various stakeholders* Food and Agriculture Organization of the United Nations, Rome, 17-19 January 2005.

EEA (2006) European forest types. Categories and types for sustainable forest management reporting and policy. In. EEA Technical Report No 9/2006. EEA, Copenhagen.

EEA (2014) *Developing a forest naturalness indicator for Europe. Concept and methodology for a high nature value (HNV) forest indicator*. EEA Technical report No 13/2014, Luxembourg: Publications Office of the European Union.

Hamor, F., Dovhanych, Y., Pokynchereda, V., Sukharyuk, D., Bundzyak, Y., Berkela, Y., Voloshchuk, M., Hodovanets, B. & Kabal, M. (2008) Virgin forests of Transcarpathia. *Inventory and management., 2008th ed. Rakhiv,*

Hengeveld, G.M., Gunia, K., Didion, M., Zudin, S., Clerkx, A.P.P.M. & Schelhaas, M.J. (2015) Gridded maps as derived from a compilation of global forest biomass estimates 1950-2010. In: (ed. O.R. Ornl Daac, Tennessee, USA. Http://Dx.Doi.Org/10.3334/Ornldaac/1296)

Kirchmeir, H. & Kovarovics, A. (ed.^eds) (2016) *Nomination Dossier "Primeval Beech Forests of the Carpathians and Other Regions of Europe" as extension to the existing Natural World Heritage Site "Primeval Beech Forests of the Carpathians and the Ancient Beech Forests of Germany" (1133bis)*, Klagenfurt.

Lõhmus, A. & Kraut, A. (2010) Stand structure of hemiboreal old-growth forests: Characteristic features, variation among site types, and a comparison with FSC-certified mature stands in Estonia. *Forest Ecology and Management*, **260**, 155-165.

Panayotov, M., Tsvetanov, N., Gogushev, G., Tsavkov, E., Zlatanov, T., Anev, S., Ivanova, A., Nedelin, T., Zafirov, N., Aleksandrov, N., Dountchev, A., Vasileva, P., Shishkova, V., Stoyanov, B., Sotirova, N., Vatov, A., Bebi, P. & Yurukov, S. (2016) *Mountain coniferous forests in Bulgaria – structure and natural dynamics*. University of Forestry and Geosoft, Sofia.

Ruete, A., Snäll, T. & Jönsson, M. (2016) Dynamic anthropogenic edge effects on the distribution and diversity of fungi in fragmented old-growth forests. *Ecological Applications*, **26**, 1475-1485.

Svoboda, M., Janda, P., Bače, R., Fraver, S., Nagel, T.A., Rejzek, J., Mikoláš, M., Douda, J., Boublík, K., Šamonil, P., Čada, V., Trotsiuk, V., Teodosiu, M., Bouriaud, O., Biriş, A.I., Sýkora, O., Uzel, P., Zelenka, J., Sedlák, V. & Lehejček, J. (2014) Landscape-level variability in historical disturbance in primary Picea abies mountain forests of the Eastern Carpathians, Romania. *Journal of Vegetation Science*, **25**, 386-401.

Tinner, R., Stalder, A. & Brang, P. (2010) Aufnahmemethode für Kernflächen in schweizerischen Naturwaldreservaten. In. Version

Tinner, R., Streit, K., Commarmot, B. & Brang, P. (2012) Stichprobeninventur in Schweizer Naturwaldreservaten–Anleitung zu Feldaufnahmen. *Birmensdorf, Eidg. Forschungsanstalt für Wald, Schnee und Landschaft WSL,*

Trotsiuk, V., Svoboda, M., Janda, P., Mikolas, M., Bace, R., Rejzek, J., Samonil, P., Chaskovskyy, O., Korol, M. & Myklush, S. (2014) A mixed severity disturbance regime in the primary Picea abies (L.) Karst. forests of the Ukrainian Carpathians. *Forest Ecology and Management*, **334**, 144-153.

APPENDIX II

Udviklingen i antallet af ynglefugle i Danmark 1800-2012 II

Lars Dinesen, Tom S. Romdal
Michael B. Grell & Erik Buchwald

(Dansk Ornitologisk Forenings Tidsskrift 110 (2016): 201-206)

Previous page: Netta rufina (photo by Erik Buchwald)

Udviklingen i antallet af ynglefugle i Danmark 1800-2012 II

Lars Dinesen, Tom S. Romdal, Michael B. Grell & Erik Buchwald

(With a summary in English: Development in the number of breeding bird species in Denmark 1800-2012 II)

Indledning

I DOFT 107: 281-290, 2013 publicerede de første tre forfattere TSR, LD og MBG en artikel, der belyste udviklingen i antallet af ynglefugle i Danmark mellem 1800 og 2012 baseret på et litteraturstudie af de væsentligste ornitologiske datakilder frem til 2012 (Romdal *et al.* 2013). Metoden er beskrevet i detaljer i denne artikel og er i korthed en analyse af udviklingen i antallet af ynglende arter i Danmark. Som kriterium er de arter medtaget, der har haft en bestand på fem sandsynlige ynglepar eller derover siden år 1800 i udvalgte skæringsår. Som skæringsår er anvendt 1800, 1850, 1900, 1945 og årene fra de to atlasprojekter 1971-74 og 1993-96 gennemført af Dansk Ornitologisk Forening. Siden 1993 er antallet af sandsynlige ynglepar for hver art opgjort årligt. Som et mål for robustheden af resultatet blev gennemført tilsvarende analyser for henholdsvis 1 og 50 sandsynlige ynglepar (se Romdal *et al.* 2013).

Siden udgivelsen af Romdal *et al.* (2013) er forfatterne blevet opmærksomme på nye data for nogle arter. Det har således vist sig, at der for otte arter var behov for en revision af vurderingen af antal sandsynlige ynglepar for 2011 og 2012. En art blev desuden tilføjet listen, nemlig Hvidvinget Korsnæb *Loxia leucoptera*, der ynglede med fem sandsynlige par i 2012 (Nyegaard *et al.* 2014). For at undersøge om dette nye datasæt ville ændre de oprindelige konklusioner, blev analyserne i Romdal *et al.* (2013) gentaget, og resultatet er publiceret i nærværende artikel.

Det fulde reviderede datasæt samt en revideret oversigt over de arter, der indenfor undersøgelsesperioden har eller har haft en bestand mellem fem og 50 sandsynlige ynglepar findes i Tab. 1 og Appendiks 1. Analyserne i nærværende meddelelse er alle baseret på kriteriet for mindst fem sandsynlige ynglepar i et givent år.

Metode

For en nærmere redegørelse af metoden henvises til Romdal *et al.* (2013). Publikationer udgivet herefter og frem til og med september 2015 er gennemgået for nye oplysninger om ynglepar i 2011 og 2012. Disse omfatter oversigten i *Fugleåret 2012* (Lange 2013), en gennemgang af truede og sjældne ynglefugle i Danmark (Nyegaard *et al.* 2014) og oversigten i *Fugleåret 2011* (Lange 2012). Ligeledes er der inddraget nye resultater publiceret efter 2013 i diskussionen.

Dansk Orn. Foren. Tidsskr. 110 (2016): 201-206

Tab. 1. Danske ynglefuglearter 1800-2012, der på et af skæringstidspunkterne har haft en bestand på mellem fem og 50 sandsynlige ynglepar fordelt efter habitatkategori (se Grell *et al.* 2005). For hver art er bestanden i 2012 vurderet (forsvundet 0; 1-4 sandsynlige par (≥ 1); 5-49 sandsynlige par (≥ 5); ≥ 50 sandsynlige par). Dertil kommer en angivelse af minimumsvurdering af bestanden i 2011 eller tidligere baseret på den danske EU-rapportering (Pihl & Fredshavn 2015), og tidspunkt for indvandring eller forsvinden er ligeledes angivet.

Habitat *Habitat*	**Art** *Species*	**2012-kategori og 2011-bestandsvurdering[1] og tidspunkt for kolonisering/forsvinden** *Population category in 2012, minimum population estimate 2011 or earlier according to Danish EU reporting and time for colonizing or disappearance*
Skov/krat *Forest/ scrub*	Hvinand *Bucephala clangula*	≥ 50; 100; indvandret i 1970erne; ingen sikre ynglefund i 1800-tallet
	Stor Skallesluger *Mergus merganser*	≥ 50; 66; Ynglefugl i 1800-tallet; tilbagegang til 10-15 par 1970erne
	Turteldue *Streptopelia turtur*	≥ 5; 100; første kendte ynglefund 1918
	Sort Stork *Ciconia nigra*	0; sidste kendte ynglepar af den oprindelige bestand 1950erne
	Svaleklire *Tringa ochropus*	≥ 5; indvandret i 1950erne; ingen sikre ynglefund i 1800-tallet
	Fiskeørn *Pandion haliaetus*	≥ 1; 3; sidste kendte par af den oprindelige bestand 1916
	Havørn *Haliaeetus albicilla*	≥ 5; 38; ikke over 50 par siden 1800
	Rød Glente *Milvus milvus*	≥ 50; 100; vidt udbredt men ikke almindelig i 1800-tallet
	Perleugle *Aegolius funereus*	≥ 1; 3; formentlig indvandret i 1960-70erne; ikke over 50 par
	Stor Hornugle *Bubo bubo*	≥ 50; 39; ikke med sikkerhed over 50 par i 1800-tallet
	Vendehals *Jynx torquilla*	≥ 5; 30; bestandstop midt/sidst i 1900-tallet
	Lille Flagspætte *Dendrocopos minor*	≥ 5; 50; indvandret i 1960erne; ingen sikre ynglefund i 1800-tallet
	Mellemflagspætte *Dendercopos medius*	0; sidste kendte ynglepar af den oprindelige bestand i 1959-60
	Sortspætte *Dryocopus martius*	≥ 50; 225; indvandret i 1960erne; ingen sikre ynglefund i 1800-tallet
	Lærkefalk *Falco subbuteo*	≥ 5; 17; tilbagegang fra slutningen af 1800-tallet
	Pirol *Oriolus oriolus*	≥ 5; 10; indvandret i sidste halvdel 1800-tallet; tilbagegang
	Nøddekrige *Nucifraga caryocatactes*	0; ikke over 50 par siden 1800
	Sortmejse *Parus ater*	≥ 50; 90 000; formentlig indvandret i slutningen af 1800-tallet
	Topmejse *Parus cristatus*	≥ 50; 15 000; indvandret i slutningen af 1800-tallet
	Fyrremejse *Parus montanus*	≥ 50; 500; Indvandret i 1970-80erne
	Rødtoppet Fuglekonge *Regulus ignicapillus*	≥ 5; 25; ikke over 50 par siden 1800
	Parktræløber *Certhia brachydactyla*	≥ 50; 1500; ekspanderet i 1900-tallet
	Sjagger *Turdus pilaris*	≥ 50; 500; indvandret ca. 1960; ingen sikre ynglefund i 1800-tallet
	Karmindompap *Carpodacus erythrinus*	≥ 5; 50; truffet siden 1960erne
	Dompap *Pyrrhula pyrrhula*	≥ 50; 15 000; indvandret i de første årtier af 1900-tallet
	Gråsisken *Acanthis flammea*	≥ 50; 6000; indvandret i sidste halvdel af 1900-tallet
	Lille Korsnæb *Loxia curvirostra*	≥ 50; 850; indvandret efter midten af 1800-tallet
	Hvidvinget Korsnæb *Loxia leucoptera*	≥ 5; ikke rapporteret; første gang registreret i 2012
	Gulirisk *Serinus serinus*	≥ 5; 20; første kendte fund i 1940erne; toppede i 1970erne
	Grønsisken *Carduelis spinus*	≥ 50; 200; indvandret i sidste halvdel af 1800-tallet
Sø/mose/å *Lake/bog/ river*	Knopsvane *Cygnus olor*	≥ 50; 3600; næsten forsvundet i 1920erne; 3-4 par i 1926
	Sangsvane *Cygnus cygnus*	≥ 1; ikke rapporteret; indvandret efter 2000
	Rødhovedet And *Netta rufina*	≥5; 8; indvandret i 1940erne; ikke over 50 par siden 1800
	Taffeland *Aythya ferina*	≥ 50; 280; ekspanderet sidst i 1800-tallet
	Troldand *Aythya fuligula*	≥ 50; 900; ekspanderet i begyndelsen af 1900-tallet
	Sorthalset Lappedykker *Podiceps nigricollis*	≥ 50; 250; første kendte ynglefund 1870erne
	Plettet Rørvagtel *Porzana porzana*	≥ 5; 28; stor tilbagegang og fluktuerende antal
	Rørhøne *Gallinula chloropus*	≥ 50; 3600; indvandret omkring 1865
	Rørdrum *Botaurus stellaris*	≥ 50; 300; næsten forsvundet omkring år 1900; 10-20 par 1970erne
	Mudderklire *Actitis hypoleucos*	0; ikke over 50 par siden 1800
	Sorthovedet Måge *Larus melanocephalus*	≥ 5; 17; indvandret i 1970erne;
	Sortterne *Chlidonia niger*	≥ 50; 53; meget markant tilbagegang i perioden
	Rørhøg *Circus aeruginosus*	≥ 50; 650; bestand < 50 par år 1900
	Pungmejse *Remiz pendulinus*	≥ 5; 6; indvandret i 1960erne
	Skægmejse *Panurus biarmicus*	≥ 50; 2000; indvandret i 1960erne
	Savisanger *Locustella luscinioides*	≥ 5; 20; indvandret i 1970erne
	Flodsanger *Locustella fluviatilis*	≥ 5; ikke rapporteret; indvandret i 1990erne
	Græshoppesanger *Locustella naevia*	≥ 50; 1100; kendt fra 1800-tallet; genindvandret i 1940erne
	Drosselrørsanger *Acrocephalus arundinaceus*	≥ 1; 7; første kendte fund 1861
	Vandstær *Cinclus cinclus*	0; 1; første kendte ynglefund 1953
	Blåhals *Luscinia svecia*	≥ 50; 265; genindvandret i 1990erne
	Bjergvipstjert *Motacilla cinerea*	≥ 50; 400; indvandret i begyndelsen af 1900-tallet

Danish breeding bird species 1800-2012 with a presumed breeding population of between five and 50 pairs some time during 1800-2012 distributed on primary habitat categories (from Grell et al. *2005). For each species, the presumed breeding population is estimated in 2012 in the following intervals (none 0; 1-4 presumed par (≥ 1); 5-49 (≥ 5) presumed pairs; ≥ 50 presumed pairs). A specific population estimate is given based on the Danish bird report to the EU (Pihl & Fredshavn 2015) based on a minimum value. Moreover, the time of colonization or disappearance from Denmark is stated.*

Habitat *Habitat*	**Art** *Species*	**2012-kategori og 2011-bestandsvurdering[1] og tidspunkt for kolonisering/forsvinden** *Population category in 2012, minimum population estimate 2011 or earlier according to Danish EU reporting and time for colonizing or disappearance*
Hede/ eng/ overdrev *Heathland/ meadow/ commons*	Knarand *Anas strepera*	≥ 50; 500; indvandret i 1900-tallet;
	Pibeand *Anas penelope*	0; første kendte ynglefund i 1916
	Urfugl *Tetrao tetrix*	0; markant tilbagegang; sidste kendte ynglefund 1998
	Trane *Grus grus*	≥ 50; 114; formentlig forsvundet i 1800-tallet; genindvandret 1952
	Hvid Stork *Ciconia ciconia*	≥ 1; 1; meget markant tilbagegang
	Hjejle *Pluvialis apricaria*	0; 3; meget stor tilbagegang
	Storspove *Numenius arquata*	≥ 50 par; 330; ynglefugl i 1800-tallet; genindvandret 1920erne
	Brushane *Calidris pugnax*	≥ 50 par; 43; stor tilbagegang; under 50 par flere år i seneste årti
	Tredækker *Gallinago media*	0; meget markant tilbagegang; sidste kendte ynglefund 1902
	Tinksmed *Tringa glareola*	≥ 50 par; 94; tilbagegang siden 1800; under 50 par i 2000
	Dværgmåge *Larus minutus*	≥ 1; 2; uregelmæssig ynglefugl i 1900-tallet
	Sandterne *Gelochelidon nilotica*	0; 1; stor tilbagegang
	Blå Kærhøg *Circus cyaneus*	0; meget sjælden ynglefugl; ikke over 50 par siden 1800-tallet
	Mosehornugle *Asio flammeus*	≥ 5; 5; sandsynligvis stor tilbagegang
	Hærfugl *Upupa epops*	0; forholdsvis almindelig i starten af 1800-tallet
	Ellekrage *Coracias garrulus*	0; spredt ynglefugl i 1800-tallet til starten af 1900
	Stor Tornskade *Lanius excubitor*	≥ 5; 5; ikke over 50 par; første kendte ynglefund 1927
	Høgesanger *Sylvia nisoria*	0; stor tilbagegang; sidste kendte fund i 1998
	Sortstrubet Bynkefugl *Saxicola torquata*	≥ 50 par; 58; tidligere mindre almindelig
	Markpiber *Anthus campestris*	≥ 1; 1; stor tilbagegang
Kyst/hav *Coastal areas*	Bramgås *Branta leucopsis*	≥ 50; 2000; indvandret i 1990erne
	Skestork *Platalea leucorodia*	≥ 50; 101; genindvandret 1996
	Skarv *Phalacrocorax carbo*	≥ 50; 32 548; forsvundet 1870erne; genindvandret1930erne
	Hvidbr. Præstekrave *Charadrius alexandrius*	≥ 50; 56; stor tilbagegang; flere år i 1990-2000erne under 50 par
	Stenvender *Arenaria interpres*	≥ 5; 30; større bestand i 1800-tallet; vurderet 100 par omkring 1900
	Alk *Alca torda*	≥ 50; 1300; koloni forsvandt omkring 1900; genindvandret 1920erne
	Lomvie *Uria aalge*	≥ 50; 2900; koloni forsvandt omkring 1900; genindvandret 1920erne
	Ride *Rissa tridactyla*	≥ 50; 340; indvandret i 1940erne
	Sildemåge *Larus fuscus*	≥ 50; 5000; fåtallig i 1800-tallet
	Svartbag *Larus marinus*	≥ 50; 1800; indvandret i 1930erne
	Rovterne *Sterna caspia*	≥ 5; ikke rapporteret; ynglefugl i 1800-tallet; genindvandret 2008
	Vandrefalk *Falco peregrinus*	≥ 5; 4; ynglefugl siden 1800; sidste ynglefund 1972; genindvandret i 2001
By/have *Urban areas*	Tyrkerdue *Streptopelia decaocto*	≥ 50; 26 000; indvandret i 1950erne
	Toplærke *Galerida cristata*	≥ 1; 2; indvandret midt i 1800-tallet; vidt udbredt; stor tilbagegang
	Husrødstjert *Phoenicurus ochruros*	≥ 50; 500; indvandret i sidste halvdel af 1800-tallet
Agerland *Arable land*	Vagtel *Coturnix coturnix*	≥ 50; 1830; tilbagegang siden 1800; nogle år under 50 par
	Engsnarre *Crex crex*	≥ 50; 150; tilbagegang fra 1800; nogle år under 50 par
	Hedehøg *Circus pygargus*	≥ 5; 22; indvandret sidst i 1800-tallet
	Slørugle *Tyto alba*	≥ 50; 55; fluktuerende; enkelte år i 1990erne under 50 par
	Kirkeugle *Athene noctua*	≥ 5; 43; stor tilbagegang siden 1800
	Biæder *Merops apiaster*	0; ynglet sporadisk i 1900-tallet; stabilt i perioden 1998-2004
	Ravn *Corvus corax*	≥ 50; 1000; nede på en anslået bestand på 16 par i 1950

1 Bestandsvurderingen følger størrelse og udvikling af fuglebestande i Danmark (Pihl & Fredshavn 2015), der udgør den danske rapportering til EU efter fuglebeskyttelsesdirektivet. Bestandsvurderingen er en minimumsvurdering foretaget i 2011 eller nærmeste foregående år, der rummer grundlag for en vurdering.

Resultater

Den reviderede analyse har resulteret i en ændret status for otte arter sammenlignet med Romdal *et al.* (2013): Rødhovedet And *Netta rufina* (2012), Plettet Rørvagtel *Porzana porzana* (2011), Sortterne *Chlidonias niger* (2011), Kirkeugle *Athene noctua* (2011), Mosehornugle *Asio flammeus* (2012), Flodsanger *Locustella fluviatilis* (2012), Hvidvinget Korsnæb (2012) og Gulirisk *Serinus serinus* (2012). Årstallene refererer til det år, der er sket en ændring i artens kategorisering som følge af gennemgang af ny litteratur. Det samlede datasæt er vist i Appendiks 1.

De nye resultater viser fortsat, at der er en stærk stigning i antallet af ynglende fuglearter i Danmark på små 30 arter fra 149 i 1800 til 178 i 2012 (Fig. 1). De to største år er 1994 med 176 arter og 2012 med 178 arter. Stigningen er stærkt signifikant (lineær regression n = 7, t = 5,69, p > 0,01). I modsætning til den oprindelige analyse i Romdal *et al.* (2013) ses imidlertid ingen tilbagegang i det samlede artsantal de sidste 20 år (lineær regression n = 20, t = -1,25, p = 0,22).

Antallet af ikke-efterstræbte arter, navnlig spurvefugle, defineret i Romdal *et al.* (2013), stiger i perioden, og stigningen topper i 1994 (Fig. 2). Stigningen er signifikant i perioden fra 1800 til 2012 (lineær regression n = 7, t = 6,94, p < 0,01). Der ses dog stadig et signifikant fald (lineær regression n = 20, t = -3,33, p < 0,01) i de sidste 20 år fra 98 arter i 1994 til 94 i 2012, på trods af at flertallet af de otte arter med ændret status er registreret med *flere* end fem sandsynlige ynglepar.

Derimod viser antallet af efterstræbte arter, herunder rovfugle og ugler, måger, ande- og vadefugle, duer, kragefugle og flere andre arter, en ikke lineær udvikling. Set over hele perioden er udviklingen ikke-signifikant stigende og når et minimum i 1900 med 70 arter og et maksimum i 2012 med 84 arter som følge af genindvandring af en række ynglefuglearter til Danmark. Set over hele perioden er stigningen heller ikke signifikant (lineær regression n = 7, t = 1,72, p = 0,14). Til gengæld er stigningen i de sidste 20 år signifikant (lineær regression n = 20, t = 2,31, p < 0,05) modsat analysen i Romdal *et al.* (2013).

Den reviderede udvikling i antal sandsynlige ynglepar fordelt på seks habitatkategorier, som omfatter skov/krat, sø/mose/å, hede/eng/overdrev, kyst/hav, by/have og agerland, er vist i Fig. 3. Resultaterne for skov/krat og sø/mose/å er forskellige fra de tilsvarende i Romdal *et al.* (2013), fordi artsantallet i disse levesteder også de seneste år er steget modsat den stagnation, der blev vist i de tilsvarende figurer i Romdal *et al.* (2013). For øvrige habitattyper er ændringerne mere beskedne eller ikke-eksisterende.

En revideret liste over danske ynglearter, hvis bestand har været mellem fem og 50 sandsynlige par i et af skæringsårene i perioden 1800-2012 er vist i Tab. 1. Samtidig er angivet en egentlig bestandsvurdering baseret på den danske rapportering til EU efter fuglebeskyttelsesdirektivet (Pihl & Fredshavn 2015).

Diskussion

En gennemgang af ny litteratur har vist, at kategoriseringen i Romdal *et al*. (2013) burde ændres for otte arter. Denne artikel bringer derfor resultaterne af en ny ana-

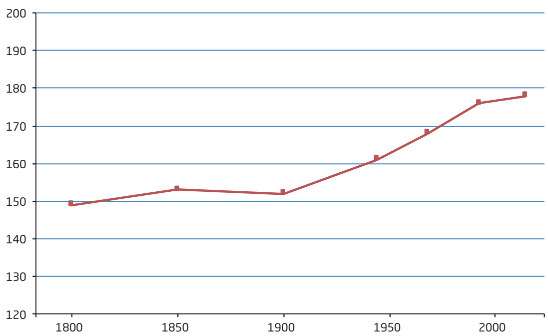

Fig. 1. Udviklingen i antallet af ynglende fuglearter i Danmark. Alle arter med minimum fem sandsynlige ynglepar 1800-2012. *The development in the number of breeding bird species in Denmark. All species with minimum five presumed pairs 1800-2012.*

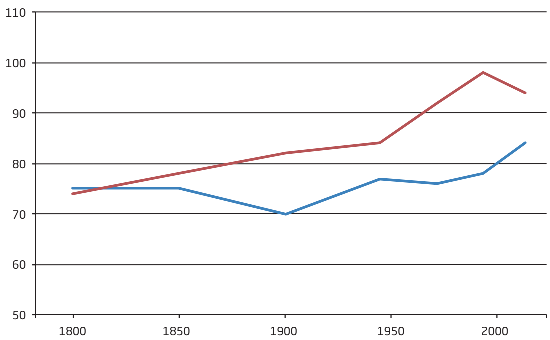

Fig. 2. Udviklingen i antallet af ynglende fuglearter i Danmark 1800-2012 fordelt på efterstræbte arter (blå) og ikke efterstræbte arter (rød) med > 5 sandsynlige ynglepar. *The development in the number of persecuted (blue) and non-persecuted (red) bird species in Denmark 1800-2012 for species with > 5 presumed breeding pairs a year.*

lyse af det reviderede datasæt. De fleste af konklusionerne i Romdal *et al.* (2013) holder efter den nye analyse, og de få undtagelser diskuteres nedenfor.

I følge denne nye analyse er der ikke længere belæg for, at det samlede antal ynglefuglearter er faldet de sidste 20 år. Resultatet skal dog stadig ses i lyset af et signifikant fald i antallet af ikke-efterstræbte arter og en stigende ornitologisk aktivitet.

Udviklingen af onlineværktøjer som DOFbasen har sammen med årlige bearbejdninger i fx *Fugleåret* (fx Lange 2012) indenfor denne periode medført en langt bedre dokumentation af ynglefugle. Samtidig har flere truede danske ynglefugle formentlig overlevet pga. en målrettet bevaringsindsats som fx opsætning af redekasser og beskyttelse af reder. Det er således tvivlsomt, om arter som Hvinand *Bucephala clangula*, Stor Skallesluger *Mergus merganser*, Hvid Stork *Ciconia ciconia*, Hvidbrystet Præstekrave *Charadrius alexandrinus*, Brushane *Calidris pugnax*, Engryle *Calidris alpina schinzii* og Hedehøg *Circus pygargus* ville være registreret som ynglefugle i hele den seneste 20 års-periode, uden den aktive forvaltningsindsats, der er foregået for disse enkeltarter.

Ses på udviklingen i de sidste 20 år (1993-2012), er der ifølge den reviderede analyse sket en signifikant fremgang for gruppen af efterstræbte arter. Vi ser for disse arter en udvikling, hvor det mest markante er et lavpunkt i antallet af arter omkring år 1900, som afløses af en stigning i artsantal. Gruppen af ikke efterstræbte arter udviser som nævnt en signifikant tilbagegang.

Set over hele perioden er det navnlig fuglearter knyttet til skovene (navnlig nåletræsarter; se også Hald-Mortensen 1971) og tilgroede vådområder, der forårsager stigningen fra 149 til 178 arter i perioden 1800 til 2012 (se Romdal *et al.* 2013 for en uddybning), idet deres fremgang mere end opvejer tilbagegangen i artsantallet for arter hovedsagelig knyttet til heder, enge og overdrev. Det er dog værd at bemærke, at almindelige nåleskovsspecialister som fx Fuglekonge *Regulus regulus* og Topmejse *Parus cristatus* de seneste årtier er

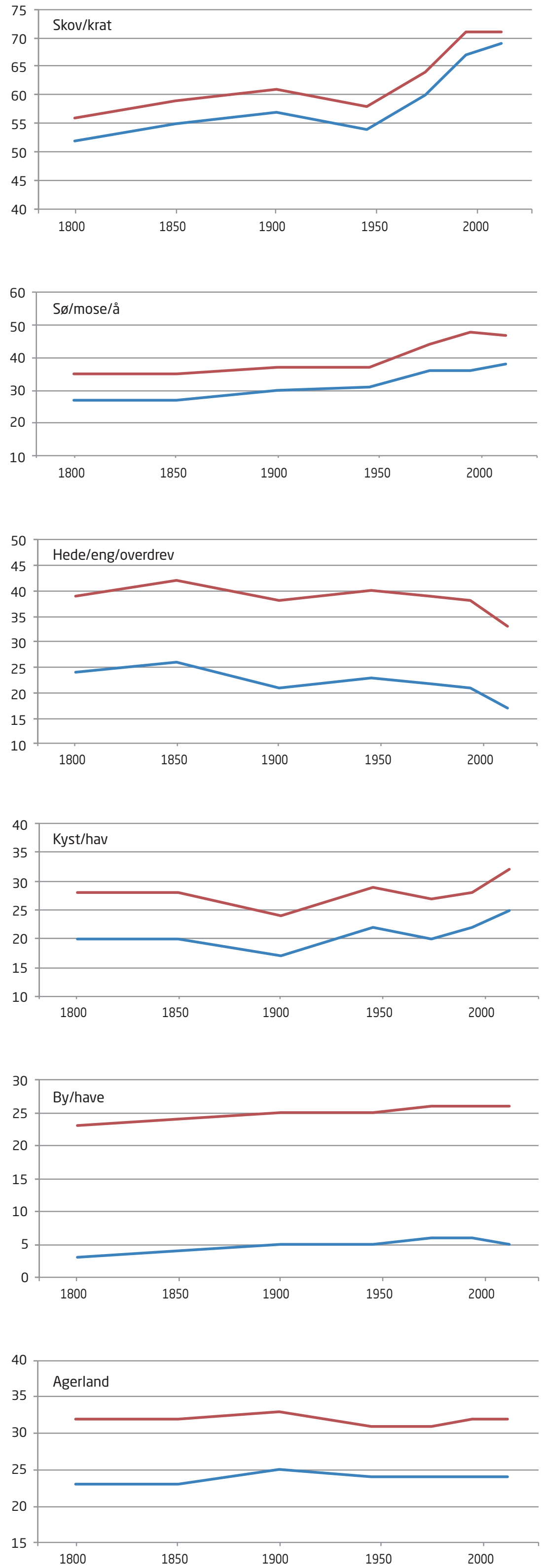

Fig. 3. Antallet af ynglende fuglearter i Danmark 1800-2012 fordelt på forskellige habitatkategorier. Alle arter er tildelt en primær og nogle også en sekundær habitat som defineret af Grell *et al.* (2005). De øverste røde linjer er summen af arter i primær- og sekundærhabitat. De blå linjer er alene arter i primærhabitaten.
The development in the number of breeding bird species in Denmark 1800-2012 divided into habitat categories. All species were given a primary and some species also a secondary habitat category as defined by Grell et al. *(2005). Upper red lines represent the sum of species in both categories, while blue lines represent the species in primary habitat only. For translation of habitats, see Tab. 1.*

begyndt at gå tilbage muligvis som et resultat af, at kvaliteten af nåleskov synes forringet (Eskildsen *et al.* 2013). Indvandringen af nåleskovsarter skete navnlig i sidste halvdel af 1800-tallet som følge af tilplantning (Levin & Normander 2008).

Det ser således fortsat ud til, at stigningen i artsantallet af danske ynglefugle er bremset op i perioden 1993-2012 trods en fortsat betydelig naturindsats og en mere omfattende registrering.

Et studie af bestandsudviklingen af europæiske fugle gennem de sidste 30 år (1980-2009) viser, at de almindelige fugle går markant tilbage i antal (i alt skønnes ca. 421 mio. individer at være forsvundet), hvorimod sjældne arter er gået frem (Inger *et al.* 2015). Den i nærværende analyse fundne fremgang i antallet af fuglearter (artsrigdom) i Danmark kan således godt dække over tilbagegang i individrigdom for almindelige arter.

Danmarks nylige afrapportering af fuglebeskyttelsesdirektivet til EU-kommissionen (Pihl & Fredshavn 2015) viser fx for perioden 1999-2011 en bred tilbagegang bl.a. for hovedparten af de ynglende spurvefugle, der overvintrer i Afrika syd for Sahara, samt for mange ynglende vadefugle.

Analyser viser, at det kan tage adskillige årtier fra beskyttelsen øges, og til bestandene af efterstræbte arter vender tilbage til deres tidligere udbredelsesområde (Brasseur *et al.* 2015). Denne tendens peger i lighed med andre undersøgelser på, at naturbeskyttelseslovgivning, fx fredning af rovfuglene i 1967, tiltrædelse af internationale naturbeskyttelseskonventioner og implementeringen af EU's naturdirektiver (fx Donald *et al.* 2007) og naturforvaltningstiltag herunder genopretning af vådområder fra 1990erne har en direkte om end ofte forsinket effekt på fuglebestandene (Sanderson *et al.* 2016) og artsrigdommen i Danmark.

Tak

Tak til to anonyme referees for konstruktive kommentarer til en tidligere version, og til Nick Quist for sproglig revision af vores engelske tekster.

Summary

Development in the number of breeding bird species in Denmark 1800-2012 II

In DOFT 107: 281-290, 2013 the three first authors (LD, TSR and MBG) presented a paper on development in the numbers of species of Danish breeding birds 1800-2012 (Romdal *et al.* 2013). Information published subsequently on Danish breeding birds made a re-analysis of the extended dataset relevant, and resulted in new categorization for eight species. The new results confirmed that numbers of breeding bird species in Denmark increased significantly from 149 in 1800 to 178 in 2012. Split into habitat types, the new results showed a continued increase in numbers of species in forest and wetland habitats in recent years. The largest decline in species numbers occurred within the group heathland/meadow/commons. The general stagnation in species richness reported in the last 20 years by Romdal *et al.* (2013) was not supported. The number of non-persecuted species, however, did show a statistically significant decline in the last 20 years. By contrast, the species categorized as (previously) persecuted increased significantly in the revised analysis over the last 20 years – indicating a comeback from an all-time low around 1900. Enhanced legal protection, landscape change, nature management and a change in mindset among the general public are believed to be some of the major drivers contributing to the long term increase in Danish bird species richness.

Referencer

Brasseur, M.J.M, T.D. van Polanen Petel, T. Gerrodette, E.H.W.G. Meesters, P.J.H. Reijnders & G. Aarts 2015: Rapid recovery of Dutch gray seal colonies fueled by immigration. – Mar. Mammal Sci. 31: 405-426.

Donald, P.F., F.J. Sanderson, I.J. Burfield, S.M. Bierman, R.D. Gregory & Z. Waliczky 2007: International conservation policy delivers benefits for birds in Europe. – Science 217: 810-813.

Eskildsen, A., J.D. Larsen & H. Heldbjerg 2013: Use of an objective indicator species selection method shows decline in bird populations in Danish habitats. – Dansk. Orn. Foren. Tidsskr. 107: 191-207.

Grell, M.B., K. Flensted, T. Nyegaard, H. Heldbjerg & T. Vikstrøm 2005: Status over Danmarks ynglefugle 2005. – Dansk Ornitologisk Forening.

Hald-Mortensen, P. 1971: Status over Danmarks Ynglefugle. Pp 167-197 i H. Hvass (red.): Status over Danmarks Dyreverden. – Rosenkilde og Bagger.

Inger, R., R. Gregory, J.P. Duffy, I. Stott, P. Vorisek & K.J. Gaston 2015: Common European birds are declining rapidly while less abundant species numbers are rising. – Ecology Letters 18(1): 28-36.

Lange, P. 2012: Fugle i Danmark 2011. – Fugleåret 6: 21-96.

Lange, P. 2013. Fugle i Danmark 2012. – Fugleåret 7: 22-102.

Levin, G. & B. Normander 2008: Arealanvendelse i Danmark siden slutningen af 1800-tallet. – Faglig rapport fra DMU nr. 682.

Nyegaard, T., H. Meltofte, J. Tofft & M.B. Grell 2014: Truede og sjældne ynglefugle i Danmark 1998-2012. – Dansk Orn. Foren. Tidsskr. 108: 1-144.

Pihl, S. & J.R. Fredshavn 2015: Størrelse og udvikling af fuglebestande i Danmark. – Videnskabelig rapport fra DCE nr. 176.

Romdal, T.S., L. Dinesen & M.B. Grell 2013: Udviklingen i antallet af ynglende fuglearter i Danmark 1800-2012. – Dansk Orn. Foren. Tidsskr. 107: 281-290.

Sanderson, F.J., R.G. Pople, C. Leronymidou, I. Burfield, R.D. Gregory, S.G. Willis *et al.* 2016: Assessing the Performance of EU Nature Legislation in Protecting Target Species in an Era of Climate Change. – Conservation Letters 9: 172-180.

Appendiks 1: http://dof.dk/doft/2016/4.appendiks1

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APPENDIX III

Hvor skal vi gøre hvad i statsskov?

Erik Buchwald

(moMentum+ nr. 3, 2015. Temanummer om biodiversitet og skov)

Previous page: Trollius europaeus in Bolderslev Forest interior (photo by Erik Buchwald)

+ AF ERIK BUCHWALD

Hvor skal vi gøre hvad i statsskov?

Naturstyrelsens prioriteringer skal danne grundlag for en revision af biodiversitetsindsatsen på styrelsens skovarealer, herunder udlæg af yderligere urørt skov og anden biodiversitetsskov

Skov-perlemorsommerfugl er et eksempel på en art, som kan spille en særlig rolle i processen, idet den er rødlistet og i fortsat tilbagegang.

FOTOS: ERIK BUCHWALD

Naturstyrelsen har på de arealer, den administrerer (statsskovene), gennem årene gjort meget for at give gode kår for arter og natur. Men de politiske vinde og forskeranbefalinger peger på, at der skal mere til. Ikke mindst hvis FN og EUs 2020 mål om at standse tilbagegangen i biodiversitet skal understøttes.

Siden 2014 har Naturstyrelsen arbejdet mere fokuseret med en databaseret prioritering af naturindsatser for at opnå bedre nytte af sine begrænsede midler, bedre inddragelse af eksterne interessenter og med stærkere fokus på opfyldelse af 2020 biodiversitetsmålene.

Denne prioritering ønskes ikke mindst at danne grundlag for en revision af biodiversitetsindsatsen på Naturstyrelsens skovarealer, herunder udlæg af yderligere urørt skov og anden biodiversitetsskov, så disse udlæg fokuseres på steder med relevante trængende arter og opfylder de stedlige arters økologiske behov.

ErhvervsPhD

For at skaffe et bedre grundlag for den forventede øgede indsats søgte og fik Naturstyrelsen derfor i 2014 en 3-årig ErhvervsPhD bevilling fra Innovationsfonden.

Projektet »*Analyse og prioritering af fremtidig indsats for biodiversitet - med særligt henblik på Naturstyrelsens arealer*« påbegyndtes 1. marts 2015 ved forfatteren, som efter ca. 23 år som forstfuldmægtig i styrelsen blev indskrevet på KU som ph.d.-studerende. Vejledere er lektor *Jacob Heilmann-Clausen* og professor *Carsten Rahbek* fra KU-CMEC (Center for Makroøkologi, Evolution og Klima) foruden kontorchef *Mads Jensen* og skovrider *Jens Bjerregaard Christensen* fra Naturstyrelsen.

Projektets formål er at undersøge og analysere, hvor og hvordan man i Danmark kan gøre en effektiv indsats for at hindre tab af biodiversitet - særligt på de ca. 2.000 km^2 af Danmark, som ejes af staten (ved Naturstyrelsen).

Her vil konkrete forslag til målrettet indsats kunne gennemføres ›

Beskyttelse af den biologiske mangfoldighed er et af de vigtige formål med Naturstyrelsens arealer

relativt hurtigt, idet beskyttelse af den biologiske mangfoldighed, herunder et rigt og varieret dyre- og planteliv, er et af de vigtige formål med Naturstyrelsens arealer.

Statsskovenes rolle

De 200.000 ha, Naturstyrelsen administrerer, svarer til ca. fem pct. af Danmarks areal. Andelen af skov og natur er dog meget højere og op mod 100 pct. for visse specielle naturtyper. Det betyder, at indsatsen på Naturstyrelsens arealer kan have afgørende indflydelse også på nationalt plan.

For at kunne hjælpe de truede arter forvaltningsmæssigt er det nødvendigt at kende deres krav til levested og hvilke trusler, der er vigtige for dem.

Oplysninger herom er af Aarhus Universitet samlet i en rødliste-database (se tabel 1), hvis data dog ikke kan stå alene. Derfor inddrages også bl.a. detaillitteratur om en mindre del af arterne.

De Økonomiske Råd har i relation til bevarelse af den danske biodiversitet konkluderet, at en stor indsats i skovene bør prioriteres højt, og at der er brug for mere målrettet indsats i den åbne natur.

Rådets analyser var i høj grad baseret på data for Danmark opdelt i 10 x 10 km kvadrater. For at gøre det mere forvaltningsegnet er der behov for at komme længere ned i skala til konkrete naturarealer, herunder skove.

Et prioritet katalog

Projektet vil derfor for Naturstyrelsens arealer gå dybere end de ovennævnte overordnede analyser og vurderinger ved at analysere og prioritere de truede arter og deres konkrete levesteder i forhold til viden om arternes økologiske behov, udbredelse og klimakrav, relation til driftsformer samt hidtidige udvikling i Danmark.

Speciel fokus ofres på arter, som ser ud til at være af særlig betydning for, at Danmark kan understøtte det politisk vedtagne 2020-mål om at standse tabet i biodiversitet.

Projektets målsætning er tredelt og vil belyse:

- Beskyttelsen af arter og naturtyper (ikke kun skov), der er særligt vigtige i relation til *det politiske 2020-mål* (1) om at standse tabet af biodiversitet, og
- At undersøge spørgsmål, som vil være af betydning for forvaltningen af truede *skovarter* (2) generelt i Danmark, og specifikt på Naturstyrelsens arealer, så der kan indføres en mere målrettet og videnbaseret indsats for arterne, samt
- At anvende resultater fra forskningen til at udforme et *prioriteret katalog over anbefalet indsats* (3), som hurtigt kan omsættes til konkret naturbeskyttelse på Naturstyrelsens arealer

Tabel 1: Rødlistedatabasens arter fordelt efter, om databasen angiver en slags skov som levested eller ej i feltet for levested. Arter uden levestedskode er udeladt.

Antal arter pr. levested	Uddød (RE)	Truet (CR,EN,VU)	Næsten truet (NT)	Livskraftig (LC)	Data deficient (DD)	I alt
Skov	137	881	240	3322	446	5026
Ikke skov	152	645	192	1842	175	3006
Sum	289	1526	432	5164	621	8032
Relativ andel						
Pct. af skovarter	2,7	17,5	4,8	66,1	8,9	100,0
Pct. af ikke skovarter	5,1	21,5	6,4	61,3	5,8	100,1

Ad. 1: Det politiske 2020-mål (skov og andre naturtyper): Til brug for den fremtidige naturindsats på Naturstyrelsens arealer gennemføres hot spot-, komplementaritets- og gap-analyse for forekomst og beskyttelse af truede arter, som spiller en særlig rolle for at nå det politiske 2020-mål om at standse tabet af biodiversitet. Analyserne vil belyse, hvor godt de hidtidigt naturbeskyttede arealer dækker de truede arter, og hvor der er mangler. Resultaterne danner grundlag for mere målrettet planlægning af naturbeskyttelsen på Naturstyrelsens arealer.

Ad. 2: Skovarter: Data for Danmarks truede arter analyseres for habitattilknytning og -præferencer ud fra data for arternes forekomst sammenholdt med Naturstyrelsens GIS-data for habitater og skovdriftstyper. De resulterende habitatpræferencer anvendes til at målrette beskyttelsen af naturmæssigt særlig værdifuld skov på Naturstyrelsens arealer med henblik på at tilgodese de truede arters behov - fx ved beskyttelse som urørt skov eller ved speciel naturvenlig drift.

Ad. 3: Prioriteret katalog over anbefalet indsats: Projektet vil dermed som noget nyt sammenkæde prioriteringsanalyser for biodiversitet på det overordnede niveau (10 x 10 km felter) eller andre storskala geografiske enheder, med konkret og operationel forvaltning på lokal skala i form af et prioriteret katalog over anbefalet indsats i konkrete områder og naturtyper. Dermed bliver det direkte relevant for selve den praktiske naturforvaltningsindsats ude i virkeligheden, som Naturstyrelsen står for.

Det prioriterede katalog over anbefalede supplerende indsatser for truede arter kan anvendes ved udmøntning af et evt. nyt nationalt skovprogram, herunder en evt. revision af områder udpeget i medfør af naturskovstrategien, og bruges til prioriteringer i det omfang, Naturstyrelsen får ressourcer til supplerende indsatser.

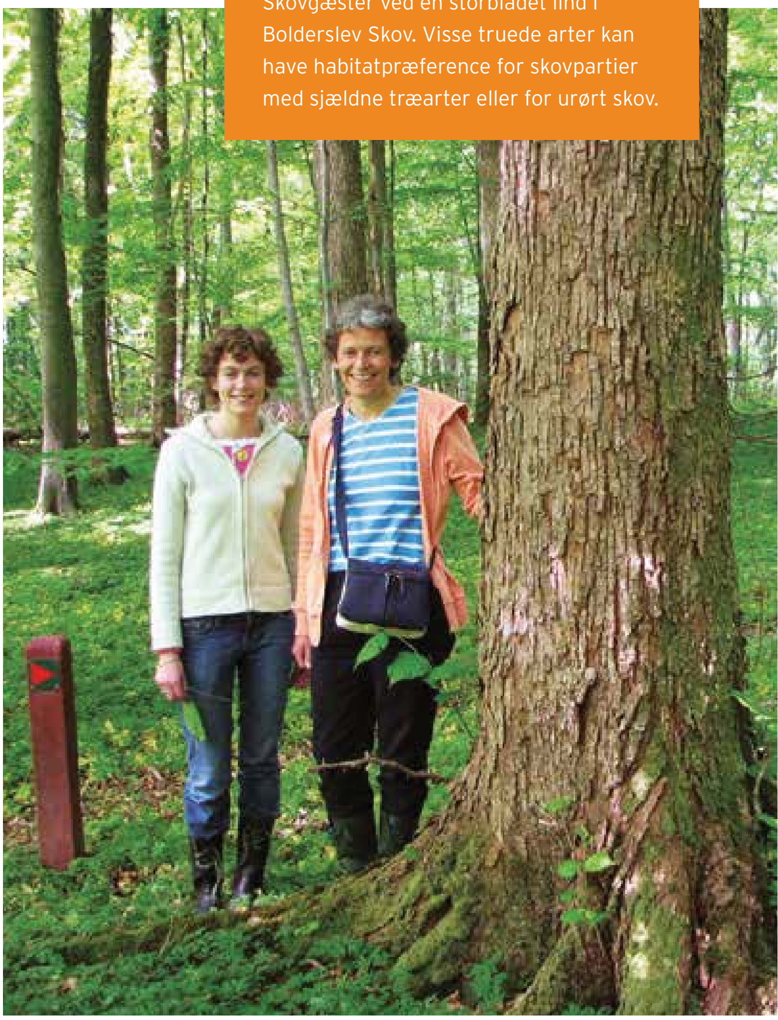
Af øvrige aktiviteter kan nævnes, at Naturstyrelsens praktikere involveres og informeres for at opnå hurtig effekt ude i praksis og for at inddrage de mange erfaringer, som ikke kan findes i litteraturen. Det vil ske ved interne møder, workshops og ved deltagelse i ekskursioner i bl.a. PROSILVA netværket for skovbrugere, som arbejder med naturnær skovdrift i praksis. Endvidere skal der selvfølgelig skrives forskningsartikler ud fra projektet.

Hvad siger 2020 målene mere konkret?

For EU er biodiversitetsstrategiens mål nr. 1 det afgørende i relation til projektet. Det handler om inden 2020 at forbedre status for Natura 2000 naturtyper, arter og fugle, dvs. naturtyperne og arter på habitatdirektivets bilag 2, 4 og 5, samt fugle omfattet af fuglebeskyttelsesdirektivet - dvs. alle vilde fuglearter.

Tabel 2 s. 30 giver et overblik over måltal og status. Den danske ændring for naturtyper (fra 17 til 5 pct. rapporteret gunstig) skyldes primært metodeforandring mellem rapporteringerne i 2007 og 2013, hvilket er uheldigt for sammenligninger.

Skovgæster ved en storbladet lind i Bolderslev Skov. Visse truede arter kan have habitatpræference for skovpartier med sjældne træarter eller for urørt skov.



EU-tallene er opgjort i de biogeografiske regioner og ikke pr. land. Det medfører, at EU-tallene ikke direkte kan oversættes til nationalt niveau, men i praksis vil være absolut minimum for hvert enkelt land, idet alle, eller i hvert fald flertallet af lande, er nødt til at opnå positiv status for, at EU samlet kan få det på regionsniveau.

FNs biodiversitetsmål for 2020 omfatter i relation til arter bl.a. at undgå uddøen af truede rødlistearter inden 2020 og at forbedre arternes status. Målet drejer sig, jf. teknisk baggrundsdokument COP/10/INF/12/Rev.1, både om globalt og om nationalt truede arter.

Biodiversitet med samfundsværdi

Undersøgelserne relateret til de politiske 2020-mål vil hjælpe styrelsen til en indsats, som kan øge sandsynligheden for at nå målet om at standse tilbagegangen i biodiversitet i år 2020.

Bl.a. De Økonomiske Råds undersøgelser har vist, at biodiversitet repræsenterer en stor samfundsværdi, der kan måles i milliarder af kroner.

Tab af arter og biodiversitet udgør tilsvarende et samfundsøkonomisk tab, som det er relevant at bruge væsentlige ressourcer på at forebygge alene af økonomiske grunde, men også pga. de etiske og moralske aspekter af naturbeskyttelse samt menneskers muligheder for at kunne opleve en rig og varieret natur.

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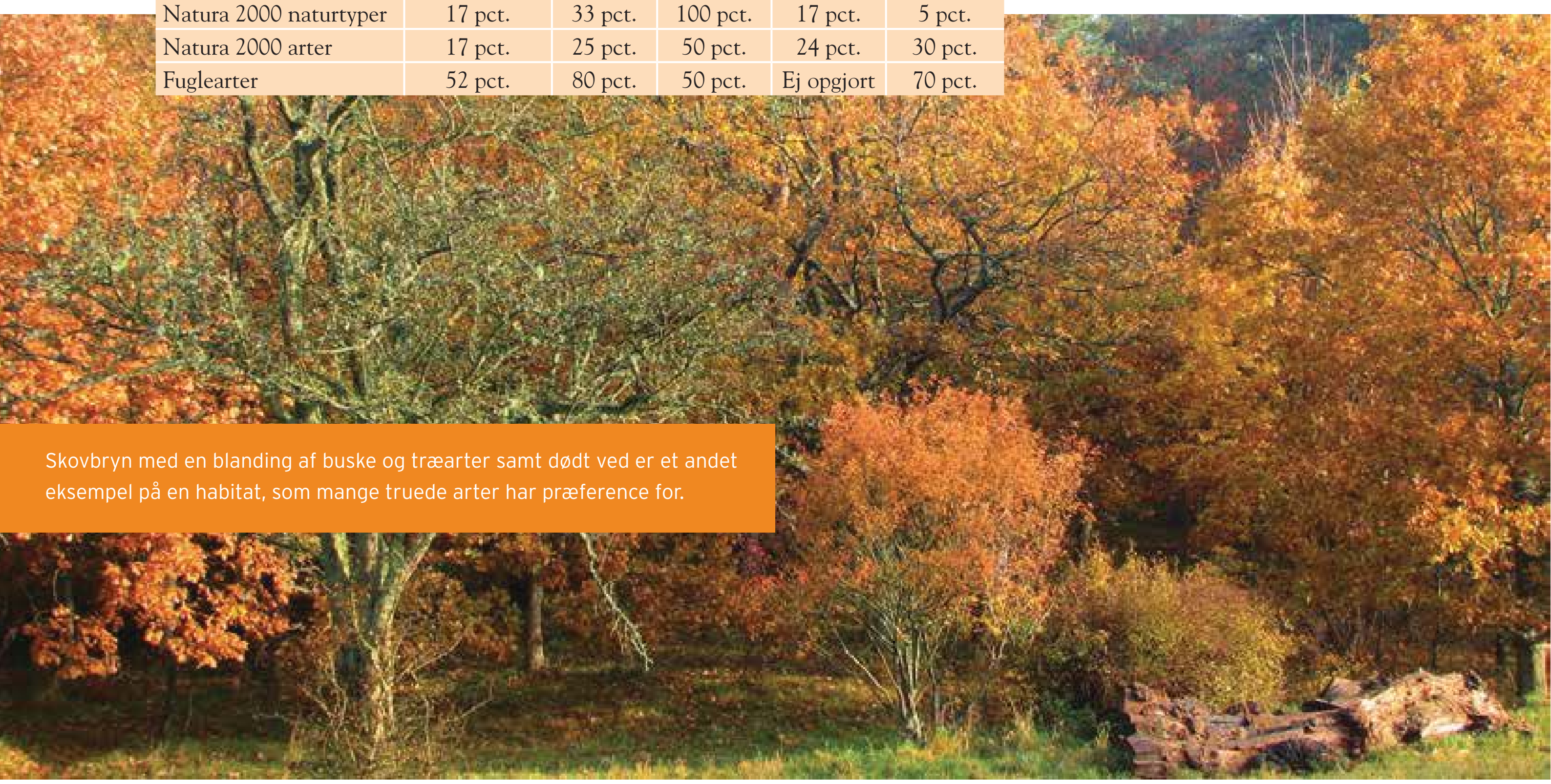
Tabel 2. Breakdown af EUs 2020 mål nr. 1 sammenholdt med status i Danmark. Jf. EUs impact assessment til strategien, dokument SEC(2011) 540 final af 3/5 2011, henholdsvis »DK_National Summary for Article 17.pdf« af 3. juni 2014.

Andel med gunstig status	Basistal (2004-2007)	2020 mål	Stigning, afrundet	DK status 2007	DK status 2013
Natura 2000 naturtyper	17 pct.	33 pct.	100 pct.	17 pct.	5 pct.
Natura 2000 arter	17 pct.	25 pct.	50 pct.	24 pct.	30 pct.
Fuglearter	52 pct.	80 pct.	50 pct.	Ej opgjort	70 pct.



Skovbryn med en blanding af buske og træarter samt dødt ved er et andet eksempel på en habitat, som mange truede arter har præference for.